THE

ELECTRICAL REVIEW.

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THE

UNIVERSAL ELECTRICAL DIRECTORY

1900

Edition

NOW READY.

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ELECTRICITY *v.* STEAM.

IN the last number of our esteemed contemporary, *Feilden's Magazine*, there appeared an editorial note under the above heading, extending a hearty welcome to the power schemes now before Parliament. With the spirit of the article we are entirely in agreement, but the startling contrast drawn between the present costs of generation in this country and abroad strikes us as an exaggeration of the facts. The price per H.P. per annum of steam-power generated from coal is said to be £25 to £30, while "on the European Continent and in the United States the same amount of power may be obtained from electricity (*sic*) at from £5 to £10 annually (the average unit costing 1d. and less)."

But it is well known that, even in this so-called *effete* country, the nursery of the steam engine, the H.P.-year of 3,000 hours costs only from £8 where the load is heavy and constant, to £20 where the load is small and variable. Wherefore, then, £25 to £30? Of course, there are numerous old crocks of engines still at work, which may run up a bill of £40 or £50 per H.P.-year; these are no more entitled to consideration than an old overshot water-wheel would be in estimating the cost of water power. Our concern is with modern appliances under modern working conditions.

But at 1d. per unit, the cost of the H.P.-year of 3,000 hours is £9·3. When to the cost of energy is added the interest and depreciation on the motors, and other charges of less moment, the total cost is well over £10 at 1d. per unit, so that to get the lowest figure quoted the unit would have to cost the consumer less than 0·5d.

The actual first cost of a complete water-power plant for generating and distributing 1,000 H.P., according to Dr. Louis Bell, amounts to about £25 per H.P. installed; this is the lowest that we have met with, the capital cost in many cases being £50 or £60, but taking this figure, the interest and depreciation alone amount at 10 per cent. to £2·5, while labour and other charges bring the total to certainly not less than £5. This may, therefore, be fairly taken as the lowest possible cost attainable in practice with water-power, or, indeed, any known source of power. From some particulars recently published in *Engineering* by Dr. Preller, relating to three Swiss hydro-electric transmissions, it appears that the average capital outlay amounts to £48 per H.P. installed; the average charge for lighting service was 7d. per KW.-hour, with rebates for long hours, and for power service 1d. per KW.-hour, or £10·24 per H.P.-year of 3,300 hours. The lowest charges in Switzerland, according to Dr. Amsler, are found at Schaffhausen, where the price is £5 a year per B.H.P. at the motor, or £6 if the supply is at low pressure. At Zürich, for small powers, £8 to £10 is charged per annum per B.H.P., and for larger powers, £6 to £7; these are Mr. Levin's figures.

Of course, if the plant is to work at full load day and

night, the cost will be much reduced; but this applies also, though to a less extent, to other systems.

The most remarkable feature of these discussions, to our mind, is that the fact, that the cost of energy consumed in turning out the finished product is exceedingly small, is constantly overlooked! In how many cases does the cost of energy amount even to 2 per cent. of the price charged for a manufactured article? And what great gain is there in reducing that small percentage by a small amount?

The real value of cheap electricity supply lies in its extreme flexibility, regularity, and ease of control, by virtue of which features the output of a factory may be, and frequently is, increased by from 10 even to 50 per cent., with the same or a less consumption of energy. In a discussion which took place at the American Institute of Electrical Engineers last year, actual figures obtained in American workshops were given, which fully bear out our statements, and we have no doubt that similar experiences have been met with in this country, although electrical driving is as yet by no means so widely adopted here as it is in other lands.

Unfortunately, it is far from easy to convince possible consumers that this is the case, and we fear that, too often, undue stress is laid on an attempt to prove to them that the cost per H.P.-hour will be less than with steam or gas. The main economy is not in the cost of energy so much as in its use, and in the reduced cost of production; this is the point that should be emphasised, and pressed home by figures collected from actual results.

Electrical Undertakers and the London Building Act.

In the *Times* for June 2nd there appeared the report of a police court case which involved a point of law of some interest to the electrical world. It appeared that the Whitechapel Board of Works were summoned by Arthur Crow, the district surveyor, for executing certain work, *e.g.*, constructing "boxes" under Great Prescott Street, without giving notice in accordance with the London Building Act, 1894. Two questions arose for decision: (1) Were the Board of Works bound to give notice, although the boxes were constructed under the provisions of the Electric Lighting Orders Confirmation Act, 1892? (2) Were street boxes "buildings, structures, or works," within the meaning of the London Building Act? Mr. Dickenson came to the conclusion that as there was nothing in the Act of 1894 which was inconsistent with that of 1892, there was no reason why the notice should not be given. He also came to the conclusion that "boxes" came within the meaning of "buildings, structures, or works" as used in the 145th, and imposed a nominal penalty. He agreed, however, to state a case. The 145th section of the London Building Act provides that where a building, *or structure*, or work is about to be begun . . . the builder or other person causing or directing the work to be executed shall serve on the district surveyor a building notice respecting the building, or structure, or work. It then sets out the details which must be furnished in this notice. According to the form of provisional order used in the metropolis, any local authority may apparently construct boxes without serving the notices which must be served by undertakers who are not the local authority. Thus by Clause 11, it is provided that subject to the provisions of the order, the principal Act and the Board of Trade regulations, the undertakers may construct in any street such boxes as may be necessary for purposes in connection with the supply of energy including apparatus for the proper ventilation of such boxes. *Provided that no such box or apparatus shall be placed above ground, except with the consent of the local authority, body, or person, by whom such street is repairable.* The words in italics are omitted in orders in favour of local authorities. The inclusion of a "street box" within Section 145 of the London Building Act is somewhat extraordinary, for it was held in the case of Venner *v.* M'Donnell [13 T.L.R., 154] that the erection of a staging in the Agricultural Hall, Islington, might be carried out without serving a notice. In that case, moreover, Mr. Justice Wills said: "It is obvious that some limitation must be put upon the natural meaning of 'structure or work,' otherwise, no person could repair his roof or windows, or put up a fixed cupboard in his bed-room, or a new kitchen range without giving notice to the district surveyor." We shall next hear of a notice being necessary before a new arc lamp post is erected in the street!

"Many Inventions."—*A propos* of some remarks on this subject published in our last issue, the marvellous possibilities of our Patent system are well exemplified by a "patent" recently granted by the British Government to an American engineer. The "invention" consists of nothing less than the combination of a row of boilers arranged in batteries of two, with mechanical stokers; a row of coal bunkers overhead, with coal chutes to the hoppers of the stokers; a coal and ash conveyor system, and an economiser fixed up aloft near the bunkers. The extraordinary combination of effrontery and *naïveté* embodied in this specification is, in truth, even more astounding than the sweeping claims set forth therein. As our readers are aware, the system patented was adopted years ago for the Dublin United Tramways, and Central London Railway Company's power stations, while it is in use in many stations abroad, with the exception that the economiser is *not* perched up above the boilers. The whole thing forms an apt commentary on the crying need of reform in our system of granting "protection" for inventions.

The Electrical Engineer Volunteers in South Africa.—Our readers will be pleased to learn the latest news that has come from the front regarding the Electrical Engineers' Corps. In a letter dated May 12th it is stated that they were then 50 miles north of Bloemfontein. The Corps had been to Bethulie, and had there been made use of for lighting the bridge for transport purposes. Telephonic communication had then been set up by the Corps between Bethulie and Springfontein, a distance of 25 miles, and proved a great success, special mention being made of the care and rapidity with which the two points were put into speaking communication. The projectors had so far been used chiefly for scouting purposes, and by this means on several occasions Boer outposts and spies were caught. At that date the Corps itself had gone forward to join Lord Roberts's main army, three officers staying behind at Bloemfontein to await Major Crompton and then proceed with him to the front. By now Major Crompton will no doubt have caught up Lord Roberts.

Royal Institution.—At a general monthly meeting on Monday a resolution was passed: "The managers of the Royal Institution of Great Britain, on the occasion of the retirement of Sir Frederick Bramwell from the office of honorary secretary, desire to place on permanent record an expression of their high appreciation of the admirable way in which he has performed the duties of that office and of his signal services to the Institution generally." He was elected a member of the Royal Institution in 1876, and has acted as honorary secretary since 1885.

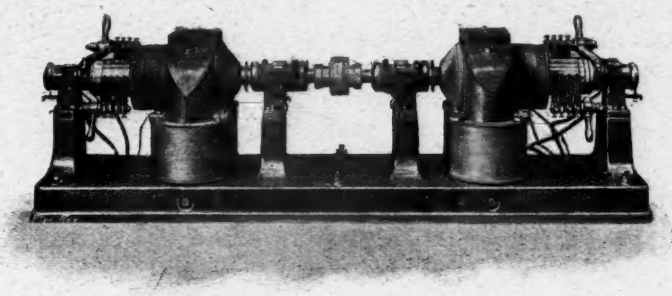
The Electric Traction Exhibition at the Agricultural Hall.—The International Tramways and Light Railways Exhibition, which promises to be a most successful undertaking, opens to the public on Saturday next week. The opening ceremony will be performed by Mr. W. H. Dickinson, chairman of the L.C.C., on Friday next.

WAKEFIELD ASYLUM ELECTRICAL INSTALLATION.

Amongst the large lunatic asylums which have recently been fitted up with a supply of electricity may well be mentioned the West Riding Asylum at Wakefield. The West Riding County Council decided to instal the electric light there, and the county surveyor, Mr. J. Vickers Edwards, then drew up a scheme embracing the lighting, heating, and ventilating, as well as the electric driving of the machinery in the workshops and laundry.

The asylum consists of the Old Main Asylum, a building of many departments and floors, having a length of 1,085 feet, and a width which varies between 225 feet to 80 feet. Close by this is a laundry which, in itself, is no inconsiderable building. Situated at a distance of about 600 yards is the New Acute Asylum, consisting of a large central building, with a main wing both for male and female patients; the length of this building is 405 feet, and the average width is 120 feet.

Between these two immense buildings are many others, such as the nurses' residence (a large self-contained isolated block), the infirmary (another similar block), the medical laboratory block, the library, a special building for male patients, and a large group of mechanics' shops where the repairs necessary for the maintenance of the asylum are carried out, the steward's residence, various lodges, and the electric engine house, which is in an isolated building. There is also a very large farm and poultry yard with the usual buildings and offices. The whole of this large group of buildings is situated within its own grounds, which have an area of over 25,000 square yards.



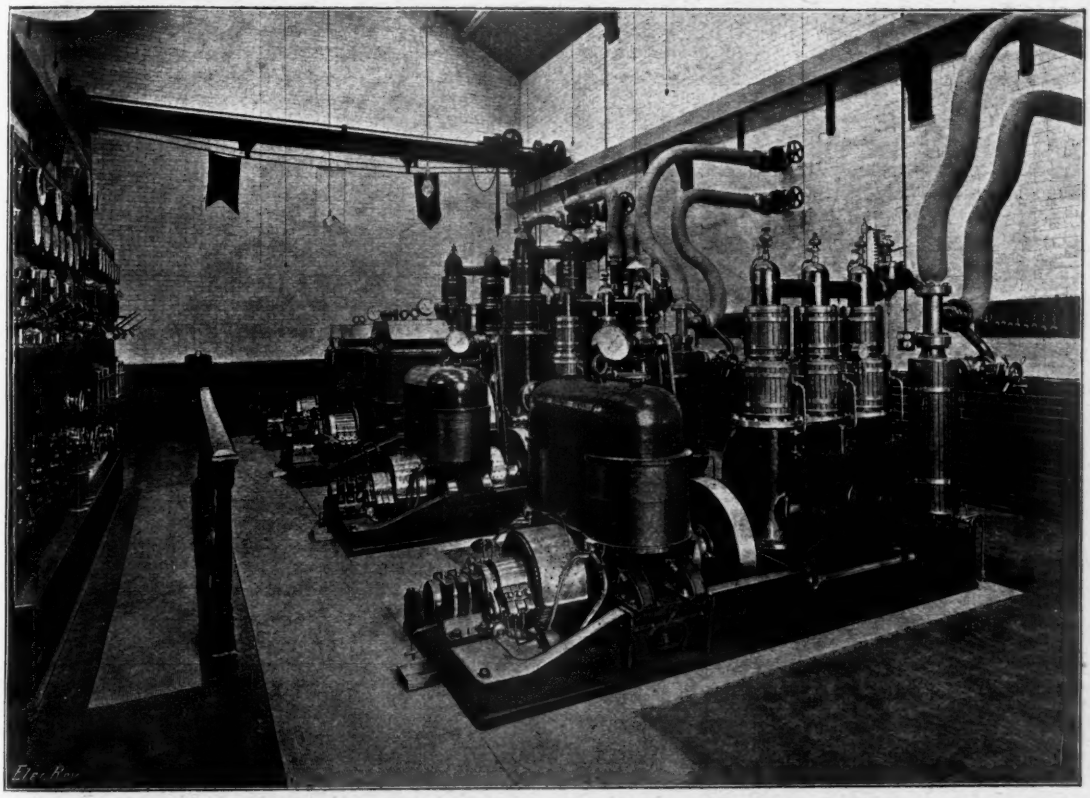
Wakefield Asylum Balancer.

The electrical machinery is steam driven from four large boilers generating steam at 115 lbs. pressure, two only being required at the same time for even the heaviest electric load. There are two large direct coupled plants, and two smaller; the larger ones consisting of Willans engines of the 2 I.S. size two-crank, driving, at about 360 revolutions, 2-pole shunt-wound dynamo machines constructed by Messrs. Parkers, Limited. The two smaller sets consist of 3 F size engines, three-crank, driving at a speed of 470 revolutions, shunt wound dynamo machines by Wilson Hartnell. The larger engines are each capable of working up to 240 I.H.P. and the smaller ones to 120 I.H.P.

The current is generated at about 420 volts, and is divided by means of a motor balancer to a three-wire supply system at 210 volts on each outer at the main switchboard.

The generating units, as will be seen from the illustration below, are conveniently placed in one row, so that all the electrical ends are under easy inspection from the switchboard, whilst the steam engines are able to draw their steam with a minimum of steam pipe in circuit. The engines are fed from two steam mains, so that the risk of breakdown, owing to trouble in the pipes, is reduced to a minimum. The special stout copper bends for steam supply are a prominent feature of the picture.

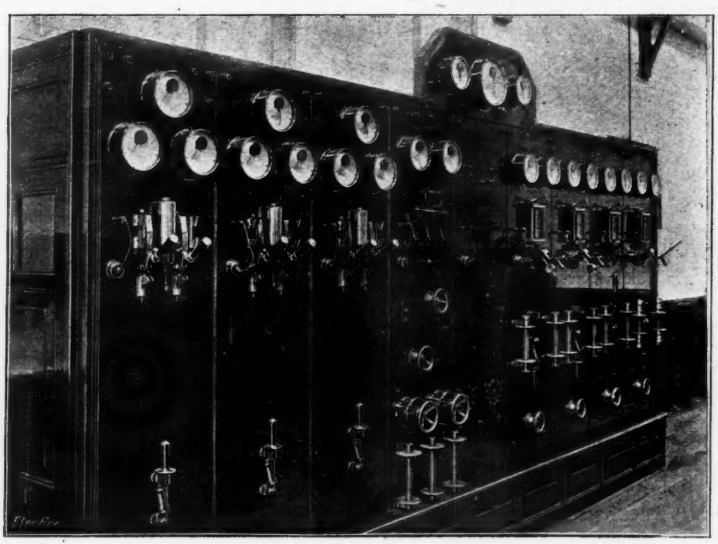
Above the plant is an overhead traveller, worked by hand, enabling inspection and repairs to be quickly and economically effected.



Generating Sets at Wakefield Asylum.

The dynamo cables pass by means of earthenware pipes to a point behind the switchboard. The switchboard is built up on the Whardown panel system, and consists of the following parts:—Four dynamo panels; two balancer panels; three feeder panels; one main voltmeter panel.

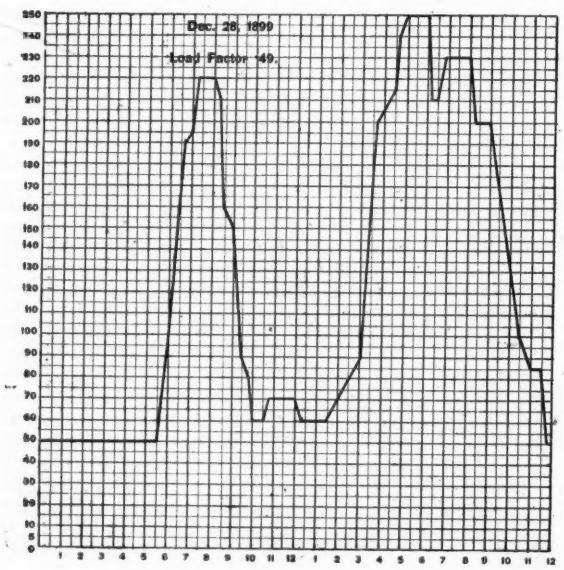
The whole is constructed on a special system using "Whardown" panel feet, by means of which the ironwork at the back of the slates is practically eliminated, enabling the connections to be carried more directly and safer from interruption, and securing very high and permanent insulation. The whole is enclosed in a polished mahogany frame, with cathedral glass panels in the doors, one at each end, and is protected in front by a hand railing.



WAKEFIELD ASYLUM SWITCHBOARD.

The dynamo panels each consist of two plug fuses, "Whardown" type, for 300 amperes and 450 volts, a quick-break main switch for the positive end of the dynamo, and a Whardown minimum current circuit breaker on the negative side. There is also an amperemeter and voltmeter for each machine, and the necessary voltmeter plug and fuses.

The balancer panels consist of three plug fuses similar to the dynamo fuses; two starting resistances, one for each side of balancer, two field regulating resistances, a treble-pole switch quick-break type, and an amperemeter on each outer.



LOAD DIAGRAM, DECEMBER, 1899.

The feeder panels consist of a middle wire quick-break Whardown type switch, a space in which will eventually be fixed a three-wire feeder meter, and above this a double-pole Ward Leonard maximum cut-out, cutting off the outer wires. On each of these panels is a voltmeter connected with a pilot wire to each feeding point, also an amperemeter on each outer wire.

Above the switchboard is the main voltmeter panel, having a large main voltmeter showing the voltage across the outers, and smaller voltmeters showing the divided voltage at the station.

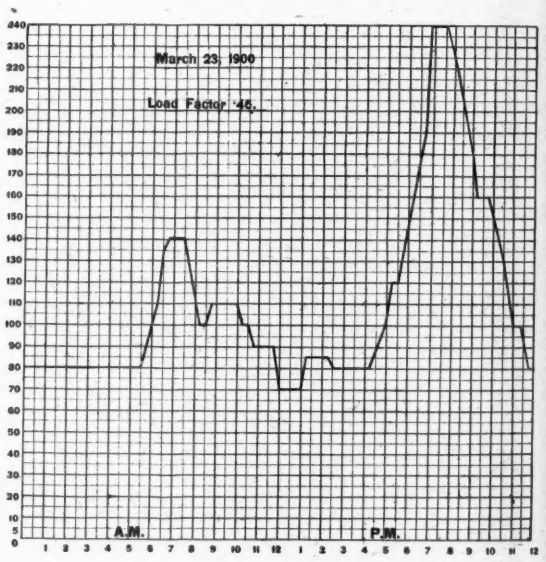
The balancers each run at about 800 revolutions, are fixed right and left of the main switchboard, and are capable of transferring 12 KW. from one side to the other of the system.

The engine room is lined inside with a dado of brown glazed bricks, and above that entirely white glazed bricks. The floor is tiled in dark red; round each dynamo is laid corrugated vulcanised india-rubber. There is a good overhead light upon the plant, and also upon the switchboard, so that the whole electrical apparatus can be kept under careful inspection at all times. Artificial lighting is provided by a number of pendants which rise clear of the traveller when it is desired to move it.

From the main switchboard the feeder cables go by means of large subways to the different feeding points.

The old asylum and the adjacent buildings are connected by means of a ring main with two feeding points, this having proved the most economical system of utilising the copper.

The section of the two feeders of the ring main is as follows:—Main A, ·45 square inch on each of the outers, and ·12 on the middle; main B, ·25 on each outer, and ·1 in the middle. The ring main itself is ·2 on the outers and ·075 on the middle on the one side between the feeders, and on the other side ·10 on the outers and ·05 in the middle.



LOAD DIAGRAM, MARCH, 1900.

The main cable to the Acute or New Asylum has a section of ·660 on each of the outers and ·120 on the middle, and is attached to distribution cable branches of ·150 on the outers and ·60 in the middle.

All the feeders and distribution mains consist of paper

insulation and yarn, and in such cases where they are exposed are armoured in addition, and have been manufactured by the British Insulated Wire Company and by Messrs. Felten & Guilleaume.

At various points along the ring main the distribution mains are fixed at junction boxes, from which are run three vulcanised india-rubber insulated conductors to the distribution boxes fixed on the different floors and to every motor; all junction boxes form disconnecting points.

The arc lamps are supplied from lead-covered and armoured paper insulated cables, some twin, and some single.

All road crossings are made through heavy iron pipes, and the cables, where under the ground, are protected by rough brick channelling.

The current is used in the asylum for three main purposes—motor power, heating, and for lighting.

The motor power is absorbed in various ways, principally by a 52-H.P. motor, now taking the place of a steam engine, used for driving the laundry machinery. There is also a 7-H.P. motor driving a blower for drying, and a 4-H.P. motor for the ironing machinery in a separate part of the laundry. The bakery has a 10-H.P. motor in the bean mill, and in another part is a pump, which, by means of an automatic switch, pumps intermittently the collected water from the various steam-heating drains to a sufficient elevation for it to pass into the regular drainage.

In many different parts of the asylum are fixed motors of 2 and 3 H.P., used in connection with the heating and ventilating of the large rooms and corridors. The motors throughout have been constructed by Messrs. Parker, and are fitted with Ward-Leonard starting resistances.

In every ward and laboratory is fitted one or more electric heaters, 5-ampere size, for boiling purposes, and in addition some of the isolated rooms, where it was difficult to supply steam heating, have been heated with several heaters, taking as much as 24 amperes at 200 volts each. The reason of utilising electric heating so largely is that part of the regular heating of the asylum is carried out by means of exhaust steam obtained from the generating engines, and it is therefore desirable to always have sufficient load upon them to enable the exhaust steam which is carried into the exhaust main at 5 lbs. pressure to be sufficient in quantity to prevent condensation.

The electric lighting consists of 2,700 incandescent lamps placed throughout the various buildings, and also 63 observation lights for use at night time, when less brilliant light is necessary in order to inspect without disturbing the patients. The observation lights consist of ordinary lamps with a Whardown lamp resistance in circuit, the whole forming a neat and perfectly safe economical resistance for lowering the voltage on any desired lamp.

The lamps are controlled by 2,000 ordinary switches, and 825 special switches worked by the asylum pass keys, fixed in all places where the patients are likely to interfere with the working of the lights.

The roads about the grounds, which are of considerable length, are lit by 60 arc lamps on wrought-iron columns with cast-iron ornamental dressings suitably placed. The arc lamps, of 2,000 C.P. each, are connected eight in series, excepting one circuit, which consists of four only. The lamps are of the Crompton type, with opalescent globes, and are hung about 25 feet above the ground level, and controlled, as far as possible, from the engine room.

The whole of the work has been carried out to the specification of Mr. Vickers Edwards, the architect, surveyor, and engineer to the West Riding County Council, who has been assisted by a resident electrical engineer, Mr. H. de Grave, as clerk of works.

Messrs. Laing, Wharton & Down, Limited, who are the contractors for the whole of the work, have been represented by their chief engineer, Mr. Justus Eck, M.A., assisted by a resident engineer.

The installation has now been continuously at work since August, 1899, when the old gas house and retorts were pulled down, but owing to delays in the building is only now entirely completed. The load curves which appear on the previous page will show that the quantity of current supplied considerably exceeds that of many small towns in this country. In fact, the whole installation, both as regards the generating station and the distribution, is carried out upon the lines of a town supply, but has the very distinct advantage that all the waste heat in the exhaust is required for steam heating purposes in rooms for cooking, washing, bathing, &c.

The actual works cost of the current supplied have now been completed for the first six months to the end of March, 1900, and give the following satisfactory results:—

Coal	·272	per unit measured at the switchboard.
Water	·019	
Oil, waste, &c.	·049	
Labour	·305	
	·645 total.	

The high load factor of the supply has undoubtedly helped to obtain these very satisfactory figures, but credit is also due to those who so carefully planned and executed the work and were responsible for its maintenance.

RYMER-JONES' SHORT CIRCUIT KEY.

A NEW form of *short circuit key*, by Mr. J. Rymer-Jones, chief electrician of the Silvertown submarine department, is illustrated below. It is designed to be used not only as a *tapper*, like the ordinary short circuit key, but to more perfectly short circuit the galvanometer when it is desired to check the instrument zero; and also to obviate any leakage over the *trigger*, cam, or other detent usually employed to retain the key "open" during insulation and earth readings.

It will be generally conceded by electricians that the ordinary form of key, though satisfactory as a *tapper*, does not afford a very perfect means of short circuiting the galvanometer.

On account of its contact points being only *pressed* together vertically, by means of the brass spring strap, any dirt accumulating between the points is only compressed, and

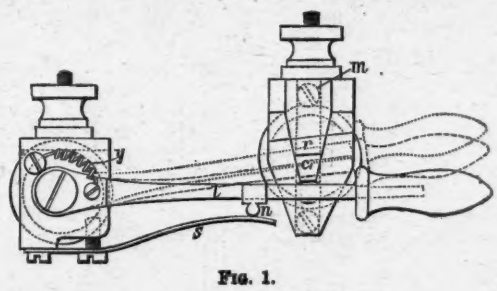


FIG. 1.

gives evidence of its presence by a black mark left on a piece of paper inserted between them to clean the contact.

It is obvious that dirt tends to increase the resistance at the contact, and on this account impairs the perfection of the short circuit, so as to allow the galvanometer needle, or coil, to be deflected slightly from its true zero. It is naturally assumed that the short circuit key perfectly fulfils its short circuiting function, and any slight deviation of the spot of light from the scale zero, when the testing current is on, is therefore likely to be attributed to some outside disturbance affecting the galvanometer. When testing with a Thomson reflecting galvanometer, this disturbing element is often really present, and it is consequently a desirable practice, and, indeed, a necessary precaution, to occasionally check the zero, during an electrification fall, by short circuiting the galvanometer. If it is then found that the spot of light does not return exactly to zero, the uncertainty arises as to whether the deviation observed is due to some temporary disturbing influence on the galvanometer, or to the short circuit key contact not being firm and perfectly clean. To verify this in the middle of a series of readings, the operator is usually driven to the unsatisfactory expedient of holding up the short circuit strap more firmly, and at the same time trying to move it from side to side in the attempt to clean the contact at the risk of bending the steady pins which should keep the strap in position. This uncertainty is set at rest by means of the Rymer-Jones short circuit key,

because a perfectly clean and firm contact between the galvanometer terminals is assured by raising the connecting strap, *l*, and moving it to the right over the rubbing contact, C_1, as shown dotted in fig. 1. This contact, being of wide surface, firm, and always kept clean by friction, may be relied on to offer no resistance, and consequently to prevent any deviation due to dirt.

Another advantage possessed by this key, when used for an insulation test, is as follows:—After the spot of light has been allowed to move up the scale to its full deflection by tapping the lever, *l*, to the left from position A, shown in figs. 1 and 3, this lever is pressed downwards, moved to the

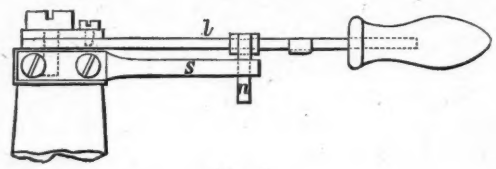


FIG. 2.

right as far as the stop, *p*, permits, and is then allowed to rise to its insulating position shown dotted at *f* in fig. 3. The limiting strap, *m*, in fig. 3 is shown dotted in fig. 1. In this position the lever, *l*, has no trigger, cam, or detent touching it, and over which leakage can take place when dirty, which is a desideratum at all times, especially in damp weather and at sea.

It will be noticed that with *l* in position, *f*, any continued swing of the needle, due to imperfect tapping of the spot to its full deflection in the first instance, may still be arrested by tapping *l* to the contact, C_3, on its left, so that in no respect is the tapping facility sacrificed for the other advantages above referred to.

The contact C_1 above *r*, and C_2 and C_3 on the two sides of *r* are of gold, while the lever, *l*, has platinum below and on its two sides. In position B, viz., when *l* is on C_1, platinum therefore rubs against gold, and reduces any tearing

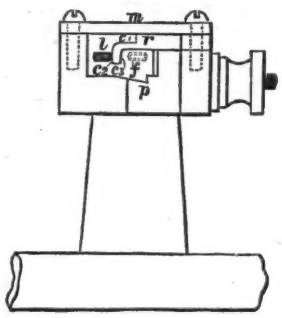


FIG. 3.

action to which two similar metals, rubbing together with considerable friction, would be liable.

A is the position of the key lever *l*, when used as a *tapper*—spring, *s*, acting strongly.

B is the position for checking the zero, viz., *l above r*, and rubbing firmly on C_1.

C is the position for insulation readings, viz., *l below r*, and free—short circuit off—spring *s* inoperative.

In position A and B, not only is the resistance between *l* and its bearing negligible by reason of the spiral wire *v*, but it is further nullified by the spring, *s*, rubbing on the pin *n*.

While therefore retaining the usual *tapper* principle unchanged, the object has been to secure the same reliable *rubbing* contact which Mr. Rymer-Jones introduced into his "discharge key" designed in 1879. This discharge key was, later on, followed by an improved galvanometer or battery reverser, constructed on the same principle, and very similar in form, which has met with great favour, owing to the reliable rubbing contacts, and the rapidity with which the key is reversed.

Both these keys, made by the Silvertown Instrument Department, have, for some years, been adopted in the factory, testing rooms, and on board that company's cable steamers, and together with the short circuit key described above, complete a set of cable testing keys, each of which admirably fulfils its special object.

RETURN FEEDERS FOR ELECTRIC RAILWAYS.

(*Continued from Vol.* 45, *page* 915.)

IT follows also from the fact that the consumption of copper is a minimum when the number of cables is infinite, that with a limited number of cables the consumption of copper is a minimum when they are connected at equal intervals along the line.

The following example will help to make this more clear (*c f*, fig. 7); let us consider two systems of intermediate cables applied to our 18-km. line in addition to the end cable. In the first case the cables are connected at 3, 6, and 9 km., and in the second case at 9, 12, and 15. In both cases the volume of copper consumed is 34,650 dcm³. If the cables are connected at 6, 9, and 12 km., then at 3, 9, and 15 km., the volume of copper is again, in both cases, the same, namely, 33,750 dcm³. Since the line is divided into two equal parts by the 9-km. cable, it is, according to the considerations discussed above, a matter of indifference whether the remaining cables are connected at 3 or 6 km., and at 12 or 15 km.; the minimum consumption of copper must therefore be when the cables are at the middle points, namely, at 4·5 and 13·5 km.; the consumption of copper in this case is only 33,075 dcm³.

In the adjacent fig. 7 the aforementioned arrangements of cable connections are diagrammatically represented; the

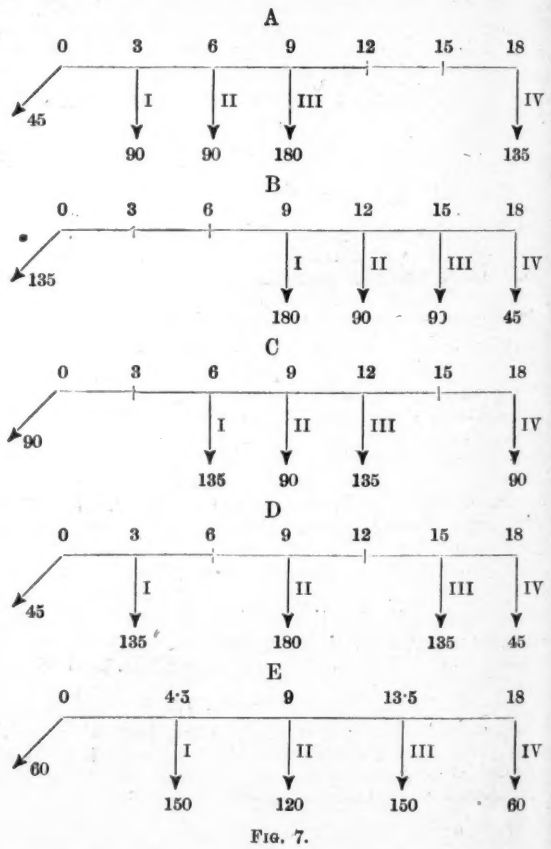


FIG. 7.

figures near the arrows representing the currents taken off by the respective conductors. The adjacent table contains the cross-sections, and the volumes of copper of each of the four cables in the five different arrangements considered

above. From this table it is evident that in the cases B and C the variation of the cross-sections is the least; in the latter case, indeed, two cables have the same cross-section, while the cross-sections in the best arrangement E differ considerably from each other. Since the consumption of copper in case B is only 5 per cent. more, and in case C 2 per cent. more than in case E, the arrangement B or C might be sometimes preferable on account of the sectional areas; but it should not be forgotten that the maximum potential difference would be greater in these latter cases.

Cables.	A.		B.		C.		D.		E.	
	s	vol.	s	vol.	s	vol.	s	vol.	s	vol.
I.	150	450	900	8,100	450	2,700	225	675	375	1,687
II.	300	1,800	600	7,200	450	4,050	900	8,100	600	5,400
III.	900	8,100	750	11,250	900	10,800	1,125	16,875	1,125	15,187
IV.	1,350	24,300	450	8,100	900	16,200	450	8,100	600	10,800
	2,700	34,650	2,700	34,650	2,700	33,750	2,700	33,750	2,700	33,075

VI.—The End of the Line is not Connected by a Cable to the Power Station.

In the cases hitherto considered, a return cable was always connected to the end of the line, so that the end of the line was always at the same potential as the beginning of the line, and the other points where cables were connected. But we may dispense with this end cable, allowing a potential drop between the end of the line and the nearest intermediate cable. This potential drop is most conveniently made equal to the potential drop between two intermediate cables. In order to obtain this result, the line must be divided into an odd number of sections, and the cables connected at the even division points (fig. 8).

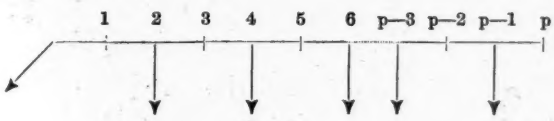


Fig. 8.

The total current between two cables is (assuming uniform distribution) $2\frac{C}{p}$, and the rail resistance is $2\frac{R}{p}$. In the last section these values are $\frac{C}{p}$ and $\frac{R}{p}$, therefore the maximum potential differences are according to the formulæ already given $\frac{4\,C\,R}{8\,p^2}$, and $\frac{C\,R}{2\,p^2}$, *i.e.*, they are equal.

If, in this formula for the potential drop m, the number of cables be substituted for p, we get

$$\Delta = \frac{C\,R}{2\,(2\,m+1)^2}.$$

According to this, there is a smaller potential drop in the rails when there is no end cable, and the number of cables is the same.

If there is only one cable, namely, an end cable, then $\Delta = \frac{C\,R}{8}$, while according to the above formula, if the cable is connected at 12 km., then

$$\Delta = \frac{C\,R}{18}.$$

That is, in the first case the potential drop in the rails is 12·5, while in the second case it is only 5·4 volts. With a larger number of cables the difference between the two arrangements gradually disappears.

The current flowing in each cable is $\frac{2\,C}{p}$; the lengths of each cable are, calling the length of line L,

$$\frac{2\,L}{p}, \frac{4\,L}{p}, \frac{6\,L}{p} \ldots\ldots \frac{(p-1)\,L}{p}.$$

From these we can calculate the total cross-section.

$$s = s_1 + s_2 + \ldots\ldots = \frac{1}{K\Delta}\frac{2\,C}{p}\left\{\frac{2\,L}{p} + \frac{4\,L}{p} + \frac{6\,L}{p} + \ldots\ldots \frac{(p-1)\,L}{p}\right\}$$

$$= \frac{2\times 2\,C\,L}{K\Delta p^2}\left\{1+2+3+\ldots\ldots\frac{p-1}{2}\right\} = \frac{4\,C\,L}{K\Delta p^2}\left(1+\frac{p-1}{2}\right)\frac{p-1}{4}$$

$$= \frac{C\,L}{2\,K\Delta p^2}(p^2-1) = \frac{C\,L}{2\,K\Delta}\left(1-\frac{1}{p^2}\right)$$

If we substitute for p the number of cables m, then since $p = 2\,m+1$;

$$s = \frac{C\,L}{2\,K\Delta}\left\{1-\frac{1}{(2\,m+1)^2}\right\}$$

This expression = 0 when $p = 1$ or $m = 0$, *i.e.*, when there is no return cable. It is a maximum when $p = \infty$, and has then the value $s = \frac{C\,L}{2\,K\Delta}$, *i.e.*, the same value as in the first arrangement.

Before investigating more closely this formula for s, we shall determine the copper volumes; this is obviously obtained from the expression:

$$v = \frac{1}{K\Delta}\cdot\frac{2\,C}{p}\left\{\left(\frac{2\,L}{p}\right)^2 + \left(\frac{4\,L}{p}\right)^2 + \left(\frac{6\,L}{p}\right)^2 + \ldots\ldots + \left(\frac{(p-1)\,L}{p}\right)^2\right\}$$

$$= \frac{1}{K\Delta}\cdot\frac{2\,C}{p}\cdot\frac{2^2\,L^2}{p^2}\left\{1+2^2+3^2+\ldots\ldots+\left(\frac{p-1}{2}\right)^2\right\}$$

$$= \frac{1}{K\Delta}\cdot\frac{2\,C\,.\,2^2\,L^2}{p^3}\frac{1}{6}\left\{\frac{p-1}{2}\left(\frac{p-1}{2}+1\right)\left(2\,\frac{p-1}{2}+1\right)\right\}$$

$$= \frac{4}{3}\frac{C\,L^2}{K\Delta p^3}\left\{\frac{p^3-p}{4}\right\}$$

$$= \frac{C\,L^2}{3\,K\Delta}\left(1-\frac{1}{p^2}\right) = \frac{C\,L^2}{3\,K\Delta}\left(1-\frac{1}{(2\,m+1)^2}\right)$$

an expression which is of exactly the same form as that for the cross-section s, differing from this only by the factor $\frac{2}{3}$ L, so that we can write

$$v = \frac{2}{3}\,L\,s.$$

Also the expression for the volume of the cables has a maximum value when $p = \infty$. We then obtain the same value, as was in previous cases obtained for an infinite number of cables.

The values of s and v have, besides the zero values, practical minimum values, namely, when there is only one cable. Assuming the condition that the potential at the end of the cable must be equal to the maximum in the other sections of the line, then

$$s = 2{,}700\,\frac{8}{9} = 2{,}400\ \text{mm}^2,$$

and

$$v = 32{,}400\,.\,\frac{8}{9} = 28{,}800\ \text{dcm}^3.$$

This arrangement is, therefore, somewhat superior to the first. It must not, however, be forgotten that the maximum potential difference in the rails is 5·4 volts. If it is desired to reduce this to 0·30 volt, it would be necessary to employ six cables ($m = 6$, $p = 13$); the cross-section would be 2,678·5 mm², and the volume of copper 32,132 dcm³. If, however, an end cable and five intermediate cables are employed, the volume of copper required is only a little more, namely, 32,850 dcm³.

When a large number of cables is used, the difference between the two arrangements disappears.

If it is desired to have the smallest possible potential drop in the rails, then it is necessary to use a large number of return feeders; then, in order to economise copper the potential drop in the cables must be made as high as possible.

(To be concluded.)

ECONOMY OF SIMPLE OR COMPOUND ENGINES FOR TRACTION WORK.

By W. H. BOOTH.

Whereas there can be little doubt as to the general superior economy of compound engines for steady loads, the conditions of electric traction are so different and peculiar that it may be questioned whether a better commercial economy cannot often be secured by simple engines than by compound.

Perhaps the best method of arriving at a definite idea would be to take a case and work out the possibilities for the two types of engine. The principal fault in a traction station is the large amount of engine power that must be put down in order to deal satisfactorily with a given load. This is due to the small proportion of the total power of the engine that is absorbed by the average load. An engine of 200-KW. capacity will on a small system be found running at an average load factor of about 40 to 50 per cent. Its maximum load will, perhaps, be 250 KW. for short periods only, and at this load there will be a distinct effort on the part of the engine to overcome it, and probably slow running for a few seconds during which the peak of the load is maintained at a maximum.

It is usual practice to design all engines so that a later cut-off than three-fourths of the stroke cannot occur. It is also very common practice to design the cylinders of compound engines with a ratio of 1 : 3. Thus with a cut-off in the first cylinder at three-fourths of the stroke, the lowest possible expansion referred to the low pressure cylinder will be 4, = cylinder ratio ÷ H.P. cut-off fraction, = $3 \div \frac{3}{4}$. With a compound engine the maximum weight of steam admitted per stroke is thus limited to what will fill the low pressure cylinder to one-fourth its capacity at the pressure of the boiler. If the same fraction be taken for the simple engine with a latest cut-off at three-fourths the stroke, then is it evident that with a simple engine there is the possibility of taking into the cylinder three times the weight of steam per stroke that can be admitted to a compound engine.

Now the all-important factor in engines for tramway work is that they shall be able to deal with their maximum load without serious retardation. Some slight retardation is permissible, because it serves to show that the engine is the smallest that could have been put in and that no further economy of size is possible.

If, however, we are permitted to leave the well-beaten path of the compound engine, we are enabled to see our way to a very considerable reduction in engine sizes. How much this is, we may most easily find from a table of average pressures, such as that in Kempe's "Engineer's Year Book," p. 253, edition 1900.

For simplicity, we will start with a pressure of 140 lbs. absolute cut-off at three-quarter stroke in a compound engine with a cylinder ratio of 3 : 1. Then, under the heading of $\frac{1}{4}$, there appears the mean pressure 85·31, whereas under the heading $\frac{3}{4}$, which is the latest cut-off for the simple engine, appears the mean pressure 134·92. With a back pressure in each case of 2 lbs., the ratio of the two numbers becomes $\frac{83{\cdot}31}{132{\cdot}92} = 62{\cdot}7 : 100$. In other words, a compound engine with a 26-inch diameter low pressure cylinder might be replaced by a simple single cylinder engine with a cylinder only 20½ inches diameter of the same stroke and speed. As a matter of fact, however, the speed of the compound engine would be 200 revolutions per minute, and that of the smaller engine might be fixed at 240. The simple cylinder might thus be made only 19 inches diameter.

By the rule that prices vary as the square root of the cube of some linear dimension, the price of such an engine should be less than three-fourths that of the compound engine. This does not allow anything for the abolition of the high pressure cylinder. This should more than off-set the increase of strength of parts of the simple engine that is to be called on to do the work of the larger compound. The average load of the compound engine was, let us assume, 50 per cent. of the rating. The rating was 80 per cent. of the maximum power. The average load is thus two-fifths of the maximum. Now the maximum load was performed with a mean pressure of 83 31. Two-fifths of this is 33·32, and this, if we add the 2 lbs. for imperfect vacuum, gives 35·32 lbs. mean forward pressure referred to the low pressure cylinder of the compound engine. This implies a cut-off at $\frac{1}{13}$ to $\frac{1}{14}$th of the stroke during the average load, with very much earlier cut-off during light loads.

As the ratio of the two engines has already been found to be as 62·7 : 100 for equal speeds, so the pressure of 33 32 will become 53·17, or 55·17 after adding the 2 lbs. for back pressure. This is the equivalent of a cut-off at a little later than one-eighth stroke, and an eight-fold expansion is probably sufficient when it is considered that this is for the mean load of the engine, and that for much of its time it is running at much lighter loads, and that the periods of maximum load are very short.

It would thus appear that by the adoption of a simple engine of half-size, run at a somewhat higher rate of speed, we should be able to secure an engine that would deal with the maximum load without being excessively large for its mean duty. In the case of the compound engine, the mean pressure necessary to perform the maximum duty was found to be 85·31 lbs. Presuming the engine to be designed to be economical at its normal rating, which is four-fifths of the full load, the mean economical pressure would be about 68·2 lbs., representing about five expansions. In the simple engine, assumed to be equal to the same duty, we have found a mean load expansion ratio of nearly eight. It does not therefore appear, even on builder's measurements, that too small an engine has been produced. Let it further be assumed that by practically reducing the engine to one-half its size, and the generator to four-fifths its former size, we have still the same mechanical efficiency. Then with an overall efficiency of the old plant of 84 per cent., the loss is 16 per cent. between cylinder and switchboard.

The loss of the new plant will probably not aggregate more than two-thirds of the gross loss. Thus a set of 100-KW. capacity throws away 16 KW. The loss in the 50-KW. engine and the 80-KW. generator will not exceed perhaps 10 KW, yet the engine will still do the work of the old set, and it will do it simply because, being a simple engine, it can, when necessary, be fed with steam for three times the proportion of the stroke of the final cylinder that can be done with the compound engine. Certainly at and near the maximum load the simple engine will be wasteful, but at the lighter loads it will be economical, for there is no such enemy to economy as under-loading a steam engine.

By a reduction of the cylinder, the ratio of the total metal exposed to the steam is decreased, but the 19 inches diameter cylinder of the simple engine is larger than the 15-inch high pressure cylinder of the compound engine it would replace. Thus, though the total radiation losses might be reduced, there would be a possible increase in the amount of the cylinder condensation were saturated steam to be employed. This points to the use of superheated steam, and there can be very little doubt but that simple high speed engines with superheated steam would prove of considerable commercial economy. The interest and depreciation charges would become 25 per cent. less on the engine alone.

The "efficiency" losses would be greatly reduced. On this point it must be said that whereas a full or rated load test would show efficiency losses overall of 10 to 16 per cent., the actual loss on the average load of one-half the rated load must be something like 20 to 30 per cent. This is one of the chief causes of the shocking want of economy of under-loaded engines. It is a constant loss that goes on when every car on the road is at rest or on a descending gradient, and it forms so large a proportion of the load as to be worth a good deal of sacrifice of nominal economy to reduce it. The simple engine at once reduces this loss to one-half or two-thirds its former figure, and it is only in the cylinder condensation losses that the simple engine is likely to do badly, and in this respect it can be placed practically on a level with the compound engine by the use of superheated steam. In any event, owing to the very large high pressure cylinders, usual in compound engines for traction work, the compound principle is shorn of some part of its benefits, and it is to be further noted that superheating cannot carry the compound engine much, if at all, further along the line of economical working than it can the simple engine.

On a general review of the whole subject, it appears that it would be justifiable to employ simple engines for traction work of such size that, when cutting off at the latest point

usual in practice, the engine shall be just capable of turning its maximum load; that to secure the best economy, the steam should be superheated; the governing of the engine should be by means of automatic expansion gear operating from absolute cut-off to three-fourths of the stroke; the parts of the engine should be specially stout, and the fly-wheel not less in energy than now employed on compound engines of the sizes intended to be replaced by the smaller simple engines.

It is to be noted that one of the advantages of the compound engine consists in the reduction of stresses due to a fuller distribution of stress. The ratio of initial stress in the simple engine to that of the compound engine it replaces may be as 1·6 : 1, and it must be proportioned accordingly. It is to be understood that the foregoing arguments are intended only with special reference to electric traction work, and must not be applied to conditions of steady load.

In the foregoing computations, the figures relating to the dimensions of the simple engine have been worked out on the assumption that the engine should be of the minimum size necessary to turn its maximum load.

It is not argued that this minimum engine will necessarily be the most economical that can be chosen. The minimum compound engine appears to be that which, at maximum load, has a cut-off equal to one-fourth of the large cylinder, whereas with a cut-off at three-fourths the above minimum size of low pressure cylinder has been found necessary. It may, of course, be the case that a somewhat larger engine will give better economy, in which case it is important to observe that the latest point of cut-off must be brought back, for, having once assumed the maximum load and the latest allowable cut-off, the engine must not be allowed to exceed that cut-off for best economy. Present practice limits the expansion to a minimum of 4. The smallest possible simple engine limits it to 1½.

The best possible expansion ratio may be 2 or it may be 3, but experience is wanting to decide the matter. To sum up the advantages and disadvantages of the change to simple engines, there are on the one hand—

Less first cost.
Less complication of parts.
Higher speeds and smaller generators.
Less wasteful running at small loads.
Reduced friction loads.
Less loss from excessive expansion at small loads.
Less area for heat radiation, and less metal to heat up and cool.

On the other hand there are—

Greater cylinder temperature variation.
Greater temperature of radiating surfaces.
Loss of the mechanical advantages of compound engines.
Greater initial stresses of simple engines.
Heavier working parts.
Less economy at heavy load.

In the above it will be observed that while the simple engine may be more wasteful in respect of radiation and cylinder internal losses than the compound engine with equal size of final cylinder, these points become much less pronounced where the engine is of reduced size, and the only really serious item is that of the wasteful use of steam at the heavier loads, when the expansion is only 1½ times. The argument of this article assumes a load factor of 50 per cent., and the figures are worked out on that basis. But in some cases the load factor is considerably less than this, and it is clear that the smallest ratio of expansion must be based on the load factor, and must vary inversely as this factor. Large systems with large load factors can be allowed greater expansion at maximum load than can small systems, and, granting that there are systems for which the simple engine may advantageously be applied, there will be a certain load factor above which the compound engine will be more economical than the simple engine. This, however, cannot be fixed at the point that gives the smallest fuel bill per kilowatt, but at a somewhat higher point, by reason of the increased first cost of compound engines and the greater interest charges. It is a strong argument in favour of the smallest possible engine for small systems that the ammeter readings remain at or near zero for long periods at a time. Throughout all this time power is being wasted in turning the engine at its maximum velocity and in the friction of the generator in driving the air and circulating pumps and the feed pumps, and all these losses except the first two can approximately be halved. A load factor of 40 to 50 per cent. is hardly likely to be exceeded under a car mileage of less than 4,000 per day, or, say, an average of 200 miles per hour. There are thus many systems that come within the limits of this argument.

It appears probable that with small systems having load factors of 20 to 40 per cent., and of 20 to 60 per cent. when referred to plant capacity the trebling of the load factor will reduce the fuel consumption per unit to one-half. This alone is sufficient to indicate the wastefulness of underloaded plant, and by the very nature of things the compound engine must be an underloaded engine, and it appears probable that a load factor of 80 per cent. is hardly likely to be attained with a less car mileage than 1,000 per hour.

ELECTRIC POWER SUPPLY.

By RANKIN KENNEDY.

The idea set forth in this connection in the Electrical Review of June 1st, that small power users will be encouraged and increase in numbers by the placing within their reach a cheap power supply, seems to me to be a great fallacy. The great demand for ordinary manufactured articles, textiles, leather, boots, hats, clothing, furniture, and so on, can never be met except by the large factory; and in the machinery and engineering trades the same holds good. Only by using extensive plant and sub-dividing labour in a large organised factory can production cope with demand at present prices.

Nowadays there is hardly a single article of manufacture produced by one worker; the manufacture is divided up between machines and workers, each performing only a fraction of the total work required. The day of the small factory is past, and rightly so. An employer of labour makes his living out of the profit on labour and material employed in his factory. A man employing 10 men, and making, without counting profit on material or machines, say, 100s. a week, must get 10s. profit on each man's work per week. Another employer, employing 1,000 men, would be making a fortune if he got 1s. a week profit on each man's work.

Of course, there will always be small industries carried on in special manufactures such as luxuries, wherein expense is of little account. More than half a century ago every town had many small factories of its own. Blacksmiths, weavers, spinners, bakers, shoemakers, tailors, and so on, and many industries were carried on in humble homes, mostly by handwork. That condition will never return; if it did, half of the population would be naked and starving, whereas under the cheap factory production, even a mill girl is at the present day able to live and dress better than Queen Elizabeth ever did.

The great revolution to be accomplished by the present electrical power distribution movement will be the vast improvement of the factory system of production, the abolition of small engines and boilers, more cleanliness, more light, cheaper commodities, more tramways, towns spreading out into the country instead of crowding into centres, and more distributed wealth among the masses.

POWER RECORDS OF ELECTRIC CARS ON THE POTTERIES ELECTRIC TRAMWAYS, ENGLAND.

The illustrations on the next page, for which, together with this article, we are indebted to the *Street Railway Journal*, show graphically some very interesting and complete records of the current and the voltage used per car on a section of the Potteries Electric Tramways, which is at present opened for traffic and working. The records include some secured while running both ways over a section with severe grades, and give reliable data for determining the actual power taken on the various gradients. Before describing the arrangements for the tests, it might be said the whole series of tests were arranged for and directed by Mr. H. M. Sayers, power engineer of the British Electric Traction Company, and

carried out by S. Sudworth, his assistant engineer, with the co-operation of Slade Olver, managing engineer to the Potteries Electric Traction Company.

The car, a single-decked one, was built by the Electric Railway and Tramways Carriage Company, Limited, of Preston, and equipped with two "33 N" Walker motors, weighing, with instruments and operators, about 8 tons. It was fitted with two speed indicators, one at each end, driven mechanically from one axle, having dials 8 inches in diameter and graduated from 3 to 15 miles per hour, an arrangement designed and patented by Messrs. Sayers and Sudworth. The grades were given by a modified form of marine clinometer. The recording voltmeter and ammeter were supplied by the well-known firm of Elliott Bros., of London, the paper speed being 3 inches per minute in each case. A similar recording wattmeter is ready for trial and will complete the set. In order to get rid of vibration the instruments were suspended in a frame, which was fitted with thick rubber blocks and screwed down to a platform across the centre of the car body. Each instrument was held in a vertical position by a pendulum rod 36 inches long and having a weight of 14 lbs. at the lower end, and violent oscillations were prevented by india-rubber guys attached to the lower part of each instrument and to the frame. The recorders were standardised against Weston instruments of well-known pattern.

An important and interesting fact which is clearly shown by the various records is the uniformity of the points given of current used at the starting of the car, with various positions of the controller handles and motors in series or parallel over different gradients.

The part of the line on which the published diagrams were taken is about 3 miles from the generating station, the drop in voltage at one of the feeder pillars being due to the trolley wires on the two sides being fed by different cables.

Diagram No. 1 was taken ascending the most severe grades, averaging about 1 in 9·5; No. 2 was taken running down the same grades, and No. 3 was taken in ascending grades, as indicated.

The value of these records in guiding tramway engineers to the adequate power equipment of cars and the power houses driving them, and the information as to tractive force required under different conditions of weather and rail, will be apparent. The superiority to the earlier method of reading instruments at intervals of a few seconds will strongly appeal to those who have tried that tiresome occupation. The extreme dead beatedness of the instruments and the success obtained in eliminating the effects of vibration of the car in motion are the important points making for accuracy. The diagrams printed show that little is left to desire in this respect.

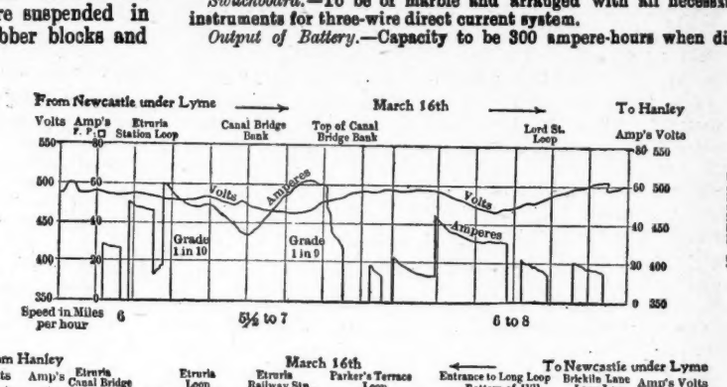


DIAGRAM I.

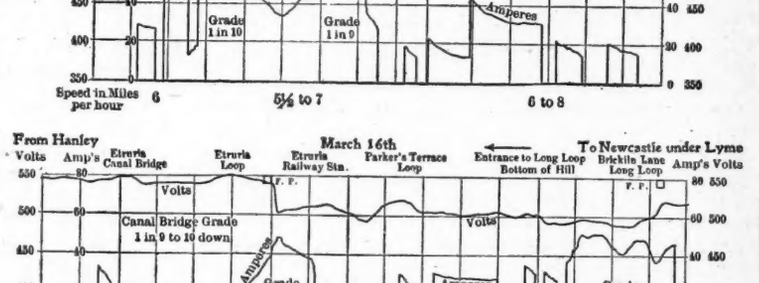


DIAGRAM II.

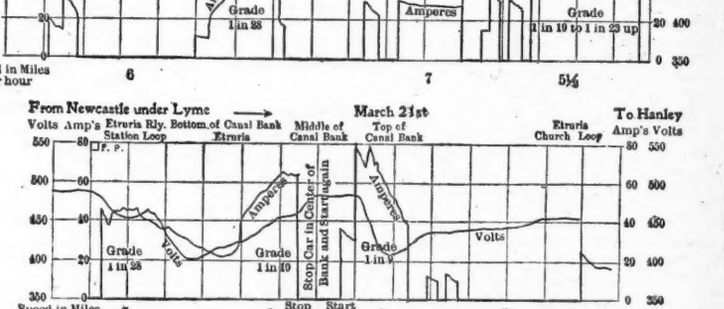


DIAGRAM III.

accumulators and motor balancers, the voltage between the middle wire and either of the outers being 230 volts.

Type and Size of Boilers.—Two of water-tube type, each capable of evaporating 6,000 lbs. of water per hour, and to work at 160 lbs. pressure to be provided.

Type of Generating Plant.—Three sets to be supplied, each to consist of vertical compound "enclosed" engine direct coupled to continuous current dynamos. Two of the sets to develop as continuous load when working non-condensing 150 KW., the other one to develop 50 KW.

Speed Specified.—Not to exceed 350 revolutions per minute for the 150 KW. sets, or 460 revolutions per minute for the 50 KW. set.

Specified Overload.—20 per cent. in excess of above normal loads for periods of one hour without injury.

Output of Balancer.—To consist of four separate machines mounted on one bedplate, the two inner machines acting as balancers, each with an output of 18 KW., the two outers as boosters each with an output of 12 KW. (100 amperes by 120 volts).

Speed of Motor Balancer and Booster.—Not to exceed 900 revolutions per minute.

Switchboard.—To be of marble and arranged with all necessary instruments for three-wire direct current system.

Output of Battery.—Capacity to be 300 ampere-hours when discharged in three hours, with terminal voltage not less than 1·82 volts, and temperature of electrolyte not higher than 60° F.

Number of Cells to be Supplied.—270.

Size of Crane.—To carry 8 tons and to be suitable for a span of 30 feet.

Insulation of Cables.—To be specified in tenders, samples being sent.

Number of Arc Lamps.—12 5-ampere lamps of "enclosed" type, each complete with glow lamp fittings and cast-iron ornamental post.

Specified Date of Completion.—To be stated by the tenderer for each section.

Penalty for Late Completion.—*One per cent.* per week on total sum due to contractor.

Terms of Payment.—80 *per cent.* as work proceeds, 10 *per cent.* on completion, and 10 *per cent.* at end of 12 months' period of maintenance.

Stipulations as to Wages paid to Workmen.—None.

Stipulations as to Removal of Foreman.—Satisfactory.

Arbitration.—Satisfactory.

Date for Receipt of Tender.—June 21st, 1900.

CURRENT SPECIFICATIONS.

XVI.—SUTTON COLDFIELD ELECTRIC LIGHTING.

SUMMARY.

Scope of Tender.—Complete equipment for electric lighting scheme divided into nine sections—(*a*) boilers, (*b*) pipework, (*c*) steam dynamos and motor booster, (*d*) storage batteries, (*e*) main switchboard and connections, (*f*) engine room travelling crane, (*g*) underground mains, (*h*) arc lamps and posts, (*i*) station lighting.

System of Lighting.—Direct current three-wire system employing

Mr. W. C. C. Hawtayne, M.I.E.E., is responsible for the preparation of this specification, and in some respects it is an improvement upon many which come under our notice. It is clearly stated that all necessary brickwork and foundations will be provided by the Corporation, though the contractor will be responsible for the accuracy of the drawings and measurements to which these foundations are made.

The boilers will in all probability be fitted with super-

heaters capable of imparting 150° of superheat to the steam generated, and an extra price is to be given in the tender for this. A 96-tube "Green" or other approved type of fuel economiser, the scrapers of which are to be driven by an electric motor, and two 1,500-gallon per hour boiler feed pumps, one of which is to be driven electrically, are also included in the plant to be supplied under this section.

The steam dynamos are to be suitable for use if required for traction work hereafter. The engine specification is so open that any well known type of engine is admissible. Tenderers must be careful in calculating the output of the dynamos. In the 150 KW. size the maximum current is 300 amperes, and the maximum volts when working as compound machines for traction purposes 550 volts. This means 165 KW., and upon this there is the 20 per cent. overload for periods of one hour, which brings the possible demand upon the dynamo to an equivalent of 198 KW. The smaller sets is just one-third of this output. The steam consumption demanded when working non-condensing with non-superheated steam at 150 lbs. pressure is for the 150 KW. set 34 lbs. per kilowatt hour at full load, and for the 50 KW. set under similar conditions, 36 lbs. These figures are severe especially in face of the clause which gives the engineer the power of total rejection if these figures are exceeded by more than *5 per cent.*

The battery of accumulators is to be maintained free by the contractor for one year, and a separate figure is to be given at which he will undertake to maintain it to *100 per cent.* of its original rated capacity for a further period of three or five years.

The underground mains section is very open, and schedules are given of the lengths and sizes upon which the tender is to be based.

In the arc lamp and post section there appears to be a clerical error, for whereas *12* lamps are specified, *20* posts are asked for; the correct number—*12*—is, however, mentioned in the tender form on page 44.

Coming to the general conditions, tenderers should remember, in complying with the following condition,

Any person tendering for the works comprised in one section may, *in addition to sending in distinct and separate tenders, also send a lump sum tender for the works included in any of the sections for which he also tenders separately.*

that the penalty for late completion of any particular section is *one per cent. of the total contract sum*—not the sum for that particular section.

With the following exception, the arbitration clause is satisfactory, though why engineers care to have such contradictory clauses in the same document as the one referring to arbitration and the following, is hard to understand.

Should there be any doubt as to the meaning of any portion of the accompanying plans, or of the specifications, or of these general conditions, **the contractor shall set forth the particulars thereof and submit them to the engineer, in order that such doubt or obscurity may be removed before the signing of the contract.**

After the contract has been signed, *the decision of the engineer in regard to the meaning of the aforesaid plans or of any dimensions, word, clause, sentence, or otherwise in the general conditions, specifications and plans, shall be final and binding on all parties.*

The provision as to supply of drawings by the successful contractor is thoroughly satisfactory, but in the present very unsettled state of the metal markets it seems unreasonable to stipulate that—

No contractor shall be at liberty to withdraw his tender until September 21st, 1900.

In view of the great difficulty existing at the present time in getting prompt delivery of materials, we hope, for the contractor's sake, that the engineers will, in calculating the amount of penalty which may possibly accrue from this cause, take full advantage of the following:—

Should the work be delayed by reason of any inclement weather, fire, *or causes not under the contractor's control,* **or in case of combination of workmen, or strikes, or lock-outs occurring in the building and engineering trades and affecting the said works, due allowance shall be made by the engineer, and the contractor is to complete the works within such time as the engineer shall consider to be reasonable, and shall from time to time in writing appoint.**

We have on several occasions been compelled to draw special attention to the unfair manner in which the maintenance clause in the general conditions has been drawn up, and it is only fair that when, as in the present case, the interests of the contractor, as well as of the purchaser, are considered, that due credit should be given.

The clause, which others may well copy, reads:—

The contractor, notwithstanding any reasonable or usual use thereof by the Corporation or their agents, or any contractors employed by them in working the station, shall be responsible for, and shall effectually maintain and uphold in good, substantial, sound, and perfect condition (fair wear and tear excepted) all and every part of the buildings, plant, machinery, &c., or other work supplied or carried out by them, for the period of 12 months from and after the day of the date of the completion thereof and handing over to the Corporation, provided always that the contractor shall be only responsible during the said period of 12 months for any defects arising from bad materials, workmanship, and design, and not for any accidents which may be occasioned by the negligence or incompetency of men in the employment of the Corporation, if they should, otherwise than through the agency of the contractor, work the station during the said period.

XVII.—BLACKPOOL ELECTRIC TRAMCAR EQUIPMENTS.

Summary.

Scope of Contract.—**Fifteen electric equipments for tramcars and trucks already on order.**

Capacity of Motors.—**The two motors on each car to be capable of propelling the loaded car weighing approximately** *twelve tons* **on dry rails up a gradient of 1 in 20 at a speed of 10 miles per hour.**

Type of Controller.—**To be of the electric rheostatic type.**

Specified Date of Completion.—**March 14th, 1901.**

Penalty for Late Delivery.—**£10 per week per complete equipment.**

Stipulations as to Wages paid to Workmen.—**See below.**

Stipulations as to Removal of Foreman.—**Satisfactory.**

Terms of Payment.—**80 per cent. as work proceeds; 10 per cent.** *three months* **after completion; 10 per cent.** *six months* **after completion.**

Arbitration.—**Limited in application, see below.**

Date for Receipt of Tenders.—**June 18th, 1900.**

This specification has been prepared by the energetic borough electrical and tramway engineer, of Blackpool, Mr. R. C. Quin, M.I.E.E. It asks for 15 electrical equipments for single truck double-deck tramcars now under construction for the Blackpool Corporation at the works of the Midland Railway Carriage and Wagon Company at Shrewsbury.

It will be noted that the motors are of larger capacity than those usually demanded for British lines, and that the controllers are to be of the electrical rheostatic type. Car lighting, heating, and erection are also to be included in the tendered amount.

The arbitration clause has incorporated in it the limitation which so impairs its efficiency, but, fortunately, all disputes relating to wages paid to workmen are to be included in its operation. As at present drafted, it reads:—

If any difficulty or dispute shall arise between the Corporation or the engineer and the contractor as to the mode of carrying out the work or the interpretation of the contract or otherwise in relation thereto, *except as to matters and things left to the sole decision of the engineer,* **under these conditions the same shall be referred to arbitration in the manner provided by the Arbitration Act, 1889, and the award of the arbitrator or umpire shall be final and conclusive on both parties, and no action shall be brought in reference to the matter in dispute except for the purpose of enforcing the award.**

Clauses 6 and 7 deal respectively with wages paid to workmen and hours of labour, and in view of the character of the work to be done, there does not seem to be anything to which the contractor can fairly take exception. They represent by far the most reasonable set of labour conditions which have recently come under our notice. The following clause (No. 8) deals with the power of the engineer to order work to be done at night, but this hardly affects the present contract.

The following is the wording of the two clauses in question:—

Clause 6.—

The contractor shall pay to every mechanic, artizan, craftsman, and labourer employed by him in the performance of this contract wages at a rate not less than the minimum standard rate of wages in force in the district in their several trades at the date of his tender, **and in case of any breach in this condition the contractor shall pay to the corporation by way of liquidated damages a sum equivalent to the difference between the aggregate amount of the wages actually paid by the contractor to his aforesaid workmen or any of them and the aggregate amount which by this condition the contractor is required to pay such workmen on account of the same services, and such sum may be deducted by the corporation from any moneys which may become payable to the contractor under this contract, or may be recovered by action.**

while clause 7 which refers to hours of labour, states:—

The contractor shall, with respect to each class of labour employed in

the performance of this contract observe the recognised hours of labour usual in the district in respect of that class, **and in case of any breach of this condition the contractor shall pay to the corporation by way of liquidated damages, a sum equivalent to the difference between the aggregate amount of the wages actually paid by the contractor to his aforesaid workmen or any of them, and the aggregate amount which he would have paid to such workman had he conformed to the requirements of this condition, and such sum may be deducted by the Corporation from any moneys which may be recovered by them by action.**

In case of any difficulty or dispute arising between the Corporation and the contractor concerning any of the matters mentioned in or arising out of the two last preceding conditions, the same shall be referred to arbitration, and all the provisions of the arbitration clause hereinafter contained shall apply thereto.

CORRESPONDENCE.

The Towns' Refuse Problem.

In your issue of June 8th, on page 958, the following extraordinary statement is made: "We are not aware of a single instance of electric light being economically and satisfactorily produced by steam generated in boilers combined with incinerators where refuse and *refuse only* is burnt."

The author of this article must really be strangely out of touch with the times, as I will proceed to show.

In September last a Meldrum Simplex destructor of eight cells and two 30 feet by 8 feet Lancashire boilers was erected at Darwen; from that time up till now, with one unit of 4 cells and one Lancashire boiler, not only has the whole of the refuse been thoroughly destroyed, but the one boiler day and night gives sufficient steam at nearly 200 lbs. pressure to the square inch, and develops 250 I.H.P. per hour for public electric lighting.

Now the public lighting of Darwen comprises 17 arc lamps, each 800 to 1,000 C.P., and private consumers take over 5,000 8-C.P. lamps; not only has *refuse alone* been the only fuel from the beginning up to this time, but no provision of any kind is made for assistance of coal fired boilers, the two boilers built in with destructor cells being the only boilers on the premises.

It will be quite evident that no humbug can attach to a case like this; further, as your contributor says, refuse varies hour to hour. It may be of interest for him to glance at enclosed pressure recorder diagram, which will show him how little the *steam pressure* varies from hour to hour throughout an average 24-hour day.

Again, I would point out that from early in September until early in June is a fair length of time, and that there is no difference in the output now as compared with the depth of winter, except that *more* consumers are constantly being added. Having constantly to report on the composition and quality of refuse in various parts of the country, I say unhesitatingly that there is such a thing as a good "average" refuse, and I am not theorising when I assert that only those who have to do intimately with refuse, have any idea as to the extent of the enormous waste going on constantly, and the consequent value of the refuse.

Generally speaking, refuse is valuable for steam raising purposes if thoroughly destroyed in properly designed high temperature cells. I have to examine refuse not only in the favourable times mentioned by your contributor, but during the whole year, in all weathers and under a vast variety of conditions. Therefore I speak from a practical standpoint and not from a balloon.

It is a pity so much fuss has been made about "the golden dustbin," because it so happens that at the very place with which "the golden dustbin" theory was first associated, Welsh coal is used at times with the same boilers that are built between the destructor cells.

In conclusion, I would advise your contributor to get into touch with the times. It is simply absurd to say that "the only really satisfactory use to which the heat of combustion of refuse has been put is in grinding clinker," when cases like the following can be enumerated (in every case coal is not used in any shape or form), unscreened refuse only.

St. Helens, Beaman & Deas patent, refuse gives 300 I.H.P. per hour for electric traction. Oldham, Horsfall's patent, gives 300 I.H.P. per hour for sanitary works and electric lighting. Canterbury, Beaman & Deas patent, gives 200 I.H.P. per hour for electric lighting. Darwen, Meldrum's Simplex patent, gives 250 I.H.P. per hour for public electric lighting. Hereford, Meldrum's Simplex patent, with 10 tons of refuse alone pumps 1½ million gallons of sewage to a height of 36 feet in 10 hours daily.

I could multiply these cases, but above will suffice to show that your contributor is either hopelessly pessimistic, or utterly out of touch with the times.

W. Francis Goodrich.
("Incinerator.")

June 8th, 1900.

[We have no wish to be pessimistic, and if the pressure recorder diagram for November 7th, 1899, which Mr. Goodrich enclosed, represents the results obtained from burning refuse alone in everyday work, we can only say that Darwen is to be congratulated upon the character of the refuse it produces. Mr. Goodrich, however, can only speak of the performance of the incinerator at Darwen from September last to date, and while we do not deny that this is a fair time over which to judge of the results of refuse burning for steam raising, it must not be forgotten that we are now coming to the season of the year when naturally the amount of cinders and half burnt coal in the refuse must sink to a minimum, and the proportion of vegetable and animal matter be largely increased.

We did not suggest that refuse was not capable of producing heat when burnt, nor did we suggest that the heat should not be utilised, nor could our statements be taken to mean that under no circumstances could the heat of combustion of refuse be utilised for electric lighting. In stating that we knew of no instance in which electric light is being economically and satisfactorily produced by steam generated in boilers combined with incinerators, where refuse, and refuse only, is burnt, we were speaking from our experience of the results of destructor plants which have been avowedly designed with a view to produce electrical energy more economically than it could be produced from coal—all other things being equal, and which have been at work sufficiently long to enable the results to be fairly criticised.

Mr. Goodrich does not mention how much refuse is dealt with at Darwen, nor how much electrical energy is produced, nor what sort of a load factor is obtained. Nor does he touch upon the vital point in our argument, namely, whether the refuse is completely consumed and the issuing gases rendered absolutely innocuous, or whether the generation of steam at constant pressure is considered of primary importance and is maintained by varying the draught?

The mere fact that steam pressure is kept constant in a boiler fired by refuse is no answer to our argument, which involves considerations of a far more comprehensive nature, the essential being the complete combustion of the refuse. Our argument, in brief, is that if every care is exercised to satisfactorily consume the refuse from a hygienic point of view, the constancy of steam pressure must be a secondary consideration, and *vice versâ*.—Eds. Elec. Rev.]

Blowing Engine Worked by Blast Furnace Gas.

In your last issue you gave particulars of tests made with a blast furnace gas driven blowing engine at Seraing, as described by Mr. Adolphe Greiner before the Iron and Steel Institute.

In the advance copies of the paper distributed at the meeting, there was a footnote on p. 4 as follows:—

We repeat here what has always been said, that no further cleaning of the gas is attempted than the usual means in use when the gas is burned in boiler furnaces. There is no special cleansing or purifying process employed. [Paper by M. Adolphe Greiner on "A Blowing Engine Worked by Blast Furnace Gas," read before the Iron and Steel Institute, May, 1900.]

It is interesting, in this connection, to consider the very indefinite sketch showing the manner in which the gas is taken from the blast furnaces to the engine.

The distance between the blast furnace and gas-driven blowing engine, as stated at the meeting, was 260 metres (853 feet), and it will be noticed from the sketch plan that there are more or less elaborate dust catchers employed near the stoves and near the gas heaters, whatever these may be, and a cooler is interposed close to the blowing engine; the

crude gas thus having (through accumulation in the long length of large diameter pipe and the dry washer and dust catcher) a considerable proportion of its dust removed before it reaches the gas heaters, but up to this point any loss of sensible heat would be a disadvantage in the employment of the gas for its combustion with air at atmospheric pressure. From this point it has to travel through a further considerable length of tubing and a cooler. As crude blast furnace gas generally carries more aqueous vapour than would saturate it at atmospheric temperature, any apparatus used for cooling must of necessity condense the excess of moisture, which, at the moment of condensation, would accumulate upon the particles of contained dust, resulting in the settlement in the cooler of a mixture of dust and water. Yet it is claimed that the engine works with gas in the condition in which it is used under boilers, and without further purification!

As the gas is at present used in boiler furnaces, owing to several causes it has only a low efficiency, and any loss of the sensible heat of the crude gas by radiation, &c., would further reduce this efficiency; all the tubing and other apparatus shown constitute, according to their efficiency, a purification apparatus.

It is hardly probable that many furnaces are so situated that the arrangement of such a length of tubing with dust catchers, &c., can be advantageously employed between the blast furnace and the desired site of the blowing engine.

The apparatus for propelling the gas, if any, is not indicated upon the sketch, nor is there any regulating gas holder shown; possibly exceptional circumstances render these unnecessary?

Steel.

Electrical Engineers in the Royal Navy.

I am evidently the man your correspondent, Mr. Ernest Hooper, is intending to go for. I accept full responsibility for every statement made in my former letter, and I stand to my guns. I need hardly point out, I presume, even to Mr. Hooper, that it does not make any difference to my contention whether a fleet engineer wears four stripes, or three and some other distinguishing mark, nor whether he ranks with a captain or with and after.

Mr. Hooper is the torpedo gunner of H.M.S. *Aurora*, and though he is the only executive officer representing electrical science in the ship, which is of nearly 6,000 tons, I trust he will excuse me when I say that I can hardly accept his guarantee, given in all good faith, of the capability of the torpedo staff in dealing with the various apparatus he mentions.

Mr. Hooper doubtless honestly believes that he and the other members of the torpedo staff could deal with the whole of the electrical apparatus on board a man-of-war, either now or in the future. What they mean is really that they would try, and that they have had no experience of the difficulties of the work beyond that in connection with torpedoes themselves.

Manufacturers and contractors are constantly having to deal with the same claims on the part of workmen who come to them for employment. Men who have done a certain portion of the work of constructing a dynamo, say, will cheerfully offer themselves to do any other part. They mean, as Mr. Hooper and the torpedo staff mean, that they will have a good try, and they do so, if allowed to, at their employers' expense.

One is also constantly meeting with men who think, or believe, that there is nothing in electricity, or in the parts of it that they have not had practical experience of, though usually they have a profound respect for that with which they have had experience, a respect that has often been knocked into them by the hard process of trial and error, in a somewhat unpleasant form.

Torpedo work, if Mr. Hooper will accept my word for it, is not the whole of electrical engineering. As our American cousins would say, "not by a dare'n'd sight." Bluejackets and naval men generally do accomplish extraordinary things on occasion, but those performances hardly warrant the gross neglect that is so rife in many other matters, nor do they make either bluejackets or their executive officers, experts in the particular work that the unexpected results are obtained in.

To take an instance, Mr. Hooper doubtless remembers, the operation of painting the ship's side, when the whole ship's company, bar the dry idlers, took part in the work. As he knows, in cases of that kind, a good deal of the painting is done with a piece of oakum, a man thinking himself particularly well off if he has a piece of flannel, yet the work is remarkably well done, and no one who had not seen the operation would believe it. I presume that Mr. Hooper would hardly claim, on the strength of that, that the executive officers of the Navy were capable of carrying out the decorations of Windsor Castle, or would be surprised if the architect, or whoever was responsible for the work, expressed doubts as to the result. Yet as Mr. Hooper will discover later on, there is as much difference between the work done in the torpedo ship, or shall I say torpedo work, and electrical engineering as a whole, as it ought to be represented in H.M. service, as between painting a ship's side, and decorating one of the great mansions of the country.

It is interesting to observe, in passing, that while there are 80 vessels of various sizes on the China station, the officers representing electrical engineering, according to Mr. Hooper's contention, consist of five torpedo lieutenants, seven torpedo gunners, and three torpedo boatswains. Assuming that these gentlemen possess all the qualifications that Mr. Hooper claims, the number does not strike one as extravagant.

But the matter I wish to impress on Mr. Hooper's mind, and the minds of all who are interested in the matter in any way, is the absurd position taken up by the executive in this matter.

It happens that electrical work is very fascinating, and fairly clean, as far as Mr. Hooper and his superiors in torpedo matters have gone, and therefore they are prepared to take a pride in the work. But Mr. Hooper will find that before he has gone very far in electrical work, he will be obliged to take a very deep interest in those nasty, greasy engines, or he will be left very much behind.

If Mr. Hooper has not yet discovered it, he will find by-and-by that he can only have electricity by conversion from some other form of energy, and that under the conditions in which he is working, steam is the cheapest agent he can employ, and further, that in order to have economy of electrical distribution, he must first have economy of steam generation, and that there can be no division of responsibility between the boiler and the apparatus that finally makes use of the energy, as heat, light, or power; and that it is as absurd to talk of terminating the responsibility of the engineer at the terminals of the dynamo, as to talk of terminating the responsibility of the officer of the watch, in the old sailing days, at the main yard. The feeling of the executive towards the engineering staff, which Mr. Hooper so curiously reflects, is a survival, more or less, from ancient days.

In the Greek and Roman Navies the ships were propelled by oars, which were usually pulled by slaves or criminals, the oars being in three banks or less, while the slave master walked up and down a gangway amidships, his whip being within reach of every oar. Naturally, those who propelled the ships in those days were looked down upon by the fighting men, who were merely passengers.

In Blake's time, though the ships were then propelled by sails, the sailing crew were quite apart from and looked down upon by the fighting men, who were again passengers. In Saxon times, and again in Nelson's time, the fighting men and the crew who worked the ship were the same, and it is to that cause that the great naval successes of those times is to be largely attributed.

It is assumed by Mr. Hooper, and by many others, that it is not necessary for the executive officers to know anything about the work of the engines beyond certain superficial knowledge that any clerk might acquire. Unfortunately, when the matter is gone into, the evidence to the contrary is overwhelming, and that whether we go to the higher ranks of the service or take the everyday working of junior officers. In the higher ranks there are two authentic cases of the disastrous results attendant on want of knowledge such as that which is A B C to the engineer.

It is now common knowledge that H.M.S. *Victoria* was lost through the want of appreciation of scientific facts, with

gives 300 I.H.P. per hour for sanitary works and electric

and a cooler is interposed close to the blowing engine; the

reference to the turning of large vessels under modern conditions, by the commander-in-chief himself.

Admirals Sampson and Schley will be acknowledged, I presume, to be as good seamen and as smart officers, as any in H.M. service. Yet there is no question that they were caught napping when Cervera made his dash, and that he would have got away, or, at least, seriously mauled one or two of his opponents, if his ships had been anything like decently found, and this was due to the fact that neither admirals nor captains understood the working of the engine room as they understood the sails in the old days. And if we look at the work of the representatives of electrical engineering as it has recently been presented to us at the Institution of Electrical Engineers, what do we find?

In the first place, a complete absence of the ability to design, and the consequent complete dependence upon manufacturers and contractors when any designs are required, with the usual adherence to obsolete patterns and wasteful apparatus. When they do design we have arrangements such as those for the attachments of incandescent lamps to their holders, that would hardly be tolerated in a tramp of the class that Captain Kettle might have commanded in his worst days.

Sydney F. Walker.

P.S.—There is a very striking article in the June number of *Cassier's Magazine* by a Surgeon-General of the United States Navy showing the Admiralty methods. The article deals with the subject from the point of view of the surgeon, but it illustrates Admiralty methods generally and very forcibly.

Steam Engine Practice.

I have lately noticed a peculiar fact in connection with "ancient and modern" steam-engine practice, which in view of the apparent growing favour with which Corliss valve gear is meeting, may prove interesting.

In a book called "Recent Improvements in the Steam Engine," by John Bourne, C.E., published in 1880 (preface dated 1869), I find a description of a Corliss engine, which, from the illustration given, appears to be almost identical with the modern article.

In criticising this the writer says:—"This form of engine is of American design, and in some quarters its advantages have been loudly vaunted. But it is not pretended that it is able to work with greater economy than ordinary engines, while the complications of its valve gear are manifest and enormous. There are four separate valves or cocks for the admission and emission of the steam, and the gear is governed by the aid of air-cushions, springs, and other rattle-traps, which, by their complexity, throw the old hand-gear into the shade. Apart from these disfigurements, however, the general plan of the engine is not so good as that of some other engines now in common use. But with these additions the engine may be pronounced to be as bad a one as perverted ingenuity could easily have constructed. The American example of this engine, shown at Paris in 1867 was of admirable workmanship, and was radiant with silver in which the cylinder was enveloped.

"But these aids to acceptation were incapable of concealing from competent observers the inherent vices of the design which appears to reckon complication as a merit, and which seeks to achieve no advantage in economy by a great multiplication of parts." Thus is the Corliss engine "described."

From what I am able to ascertain, Bourne seems to have been a leading engineer in his day, and was the author of four or five works on the steam engine. He designed marine boilers. In 1838 he took out a patent for using steam expansively in steam vessels. He invented many accessories to marine engines, and he appears to have been practically the first man to run a traction engine in India.

In some directions he was distinctly a genius, and this ends to cause one some surprise that he should have allowed mere external appearances to have prejudiced his opinions to such an extent. Possibly the low pressures then in vogue influenced him.

I wonder whether we shall have to wait 30 years before the steam turbine and the oil engine are appreciated to the same degree, in proportion, as the Corliss valve gear?

Ivon M. de Havilland.

June 5th, 1900.

The Protection of Insulated Wires.

Pressure of other work has prevented me from replying to Mr. Bathurst before.

I now beg to thank him for his courteous criticism of my article, and for his offer, though I am afraid I do not quite understand what it amounts to.

I think, as far as I am able to follow Mr. Bathurst's criticism, that we are practically of one mind on the main principles, and on the main lines that practice has to follow.

There is one point, however, on which I think we are hardly in agreement, viz., the life of the insulation of the wires.

I have never met any firm of cable makers, or wire coverers, who were prepared to guarantee the insulating envelope of their wires or cables for 10 years, from the date of supply or use. Is Mr. Bathurst prepared to guarantee the lining of his pipes for that period; to give a guarantee for that period similar to that given for a certain period by engine builders, &c.?

Sydney F. Walker.

Bath.

THE STASSANO PROCESS FOR THE PRODUCTION OF IRON AND STEEL.

By JOHN B. C. KERSHAW, F.I.C.

The experiments which have recently been made in Italy with the Stassano process for the production of iron and steel, raise once again the much discussed question of the economy of the electric current when used for heating purposes. That the subject is worth attention is proved by the fact that a company with a capital of £36,000 has been exploiting this process at Cerchi, in Italy, and that it is now proposed to form a larger company and to erect a plant capable of producing 4,000 tons of iron per year in the valley of Camonica, in the Bergamosca Alps.

1,500 H.P. will be used at this works in three furnaces of the Stassano type. The iron ore is reduced to a state of fine division, and is mixed with the requisite proportions of lime and coke similarly ground to powder. The mixture is then moulded into briquettes with a suitable binding material, and these are heated in the electric arc in the specially-designed furnaces. The operation of the furnaces is continuous, arrangements being made for tapping the slag and the reduced metal, at regular intervals of time. The experimental furnace at Cerchi was 3 metres high, and required 1,800 amperes at 50 volts pressure. The output was 30 kgs. metal per hour.

A similar process is also about to receive trial at Prague, in Austria.

Before discussing in detail the figures given above for the actual work of the Stassano furnace at Cerchi, it will be useful to examine the present state of scientific knowledge in relation to the theoretical efficiency of the electric arc when used for heating purposes.

Messrs. Gin and Leleux have recently contributed some notes on this subject to the French Academie des Sciences. (*Comptes Rendus*, 126, p. 36.)

In this contribution they give the equation—

$$t = \frac{1}{A}\left(\frac{I}{s}\right)^2 \frac{p}{c}, \text{ in which}$$

lost through the want of appreciation of scientific facts, with

F

p = resistance of the envelope of gas
c = Sp. heat of gas per unit of volume
s = sectional area of the electrodes
t = temperature of arc.

According to this equation the temperature (t) increases directly as the square of the current density, and directly as the ratio of the total resistance of the gaseous envelope to the Sp. heat of unit volume of the same. These two last factors themselves vary with t. But this equation is only put forward in a tentative manner, and owing to the absence of the necessary data relating to the values for (p) and (c), it cannot be used for calculating the temperature that ought to be attained in the Stassano arc furnace.

The Joule equation—

$$h = \cdot24 \times C^2 \times R \times t,$$

which yields such reliable and valuable information when applied to the passage of the electric current through solids and liquids, can also be extended to the case of gases, and therefore to arc heating; but here again, owing to the lack of the necessary data, little help is obtained by its use. The gases surrounding the carbon poles of the arc are at an enormously high temperature, and even their composition is a matter of conjecture rather than of exact knowledge. Chemical analysis can assist little in revealing their composition, for on removal from the neighbourhood of the arc re-combinations occur, and the gas analysed is totally different from that which surrounded the carbon poles.

For these reasons the two equations given above are practically useless, and it is impossible at present to compare the actual efficiency of an electric arc furnace with that calculated from the Joule equation.

If the whole of the energy put into the Stassano furnace were employed in reducing the iron oxide to the state of metal, the thermal efficiency of the whole process might be accepted as the thermal efficiency of the furnace.

But it is necessary to recognise that electric arc heating cannot be an economical method of effecting a reduction that takes place at a comparatively low temperature—and that in the Stassano furnace, a large number of chemical and physical changes in the solids and gases must be brought about, which are not necessary for the conversion of ferric oxide into metallic iron, and simply represent wasted energy. The ideal furnace for iron reduction is one in which the temperature attained is but slightly above that required for the reaction between Fe_2O_3 and C, and for liquefaction of the resultant metal and slag. A furnace, the temperature of which approaches 3,000° C., and resolves most compound gases into their constituent atoms, must necessarily be wasteful in operation.

Turning now to a consideration of the experimental data relating to electric arc heating, one finds little of scientific value.

Siemens and Huntingdon communicated to the 1882 meeting of the British Association at Southampton the results of experiments upon the fusion of metals by aid of the electric arc; but they gave no details upon which calculations of thermal efficiency could be based.

Moissan, the distinguished French chemist, whose book upon the electric furnace * is generally recognised as the standard work of reference upon the subject, gives very full details of the current, time, and E.M.F. employed in his experiments, but as he does not record the weight of materials used, or weight of metal produced, his figures cannot be used for the desired calculations.

Confining one's attention, therefore, to the figures supplied by those interested in the Stassano process, we have the statements that originally 4·08 E.H.P. hours yielded 1 kg. of manganiferous steel of good physical properties, but that improvements have been made which now reduce the energy consumption to 2·7 E.H.P.-hours per kg.

Taking the cost of water-power at Niagara as basis of our calculation (87s. 6d. per E.H.P.-year of 8,760 hours), this works out to ·3234d. per kg. metal produced, or 26s. 11d. per metric ton. The estimate of the Stassano Company is, however, based upon a much lower cost of power, as it is stated that in Italy 3,000 E.H.P.-hours can be obtained for 18 francs = 42s. per E.H.P.-year of 8,760 hours. Using this lower figure of cost, the expenditure upon electrical energy would represent only 13s. per metric ton of iron or steel.

The consumption of coke will, of course, be less by the new method of manufacture than in the ordinary blast furnace procedure. The most reliable figures relating to the latter are those contained in Sir Lowthian Bell's work on the manufacture of iron and steel. The consumption of coke in the blast furnace is there given as 19·5 cwts. per ton of iron produced, and there is strong ground for believing that in the newest furnaces this has now been reduced to 16 cwts. It has been calculated that a thermal efficiency of 74 per cent. is attained, a result unapproached in any other form of fuel-consuming apparatus. According to Turner,* 6·45 cwts. of this total are required to combine with the oxygen of the ferric oxide, and are, therefore, necessary for mixing purposes in the Stassano method of manufacture. The saving in coke by the electrical method of heating is, therefore, equal to 16 — 6·45 = 9·55 cwts. per ton of iron produced.

Taking the price of coke in this country as 22s. per ton, the total cost of the fuel required for heating and reducing purposes in the modern blast furnace works out to 17s. 7d. per ton of iron produced; and the net saving in coke by use of the electric arc for heating purposes would amount to less than 11s. per ton. Against this gain, one has to place an expenditure of from 13s. to 27s. per ton of metal produced by the Stassano furnace, for electrical energy, plus the increased cost of preparing the ore for treatment by grinding, mixing and formation into briquettes.

It is true that the metal obtained from the Stassano furnace is said to be a manganiferous steel of high carbon contents, and that its value is, therefore, considerably higher than the metal produced by the blast furnace. But until further practical trials have been made with the Stassano process of manufacture, it would be unsafe to assume that the carbon, silicon, and manganese contents of the iron can always be obtained in the desired amount in metal produced by the smelting operation, and in many cases the writer fears it will be found necessary to pass the metal obtained through further operations in order to produce a merchantable steel.

It is therefore improbable that the electrical method of iron and steel production will enter into active competition with the older blast furnace method of manufacture in countries where fuel is reasonably cheap, and the Stassano process is only likely to prove successful at present in countries where fuel is expensive, water-power abundant, and heavy protective tariffs on iron and steel exist.

In conclusion, it is only fair to the promoters of the new company to give the figures upon which they base their estimates of successful work, and hopes of realising a profit upon the new venture. Owing to the scarcity of fuel in Italy, ordinary smelting costs 128s. per ton of iron, of which total 26s. 5d. represents the value of the fuel used for heating purposes. By the Stassano process this fuel will be replaced by electrical energy costing 14s. 5d., and the whole process will be carried out at a cost of 80s. per ton, a saving of 48s. per ton as compared with the cost of the older process.

That these figures are more favourable than those calculated by the writer is due to the fact that they relate to Italy and not to England, and also in part to the proverbial hopefulness of inventors and promoters with regard to the prospective profits of undertakings in which they may happen to be financially interested.

* "Le Four Electrique," Paris, 1897.

THE STRENGTH OF STEEL BALLS.

The results given below in the form of a table were obtained at the Rose Polytechnic Institute, during some preliminary tests connected with the design of ball bearings for experimental purposes. The balls were obtained direct from the manufacturers.

The extreme difficulty of testing the breaking strength or crushing resistance of steel balls is at once apparent, and the first experiments in crushing between two flat plates of the hardest tool steel obtainable were quite unsatisfactory.

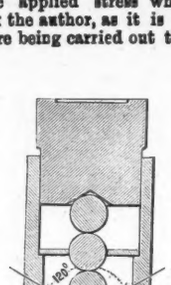
After trying several brands of steel the method shown in fig. 1 was

* "The Metallurgy of Iron," Turner, p. 173.

ends to cause one some surprise that he should have allowed

adopted, in which the hardness of the steel ball is itself used to obtain a mutually unyielding surface.

The figure indicates the method of testing with sufficient clearness, but it is evident that unless the three balls are exactly in line so that the line of pressure passes through the centre of gravity of each ball, it is quite impossible to obtain anything more than a rough approximation of the applied stress which crushed the ball. This must have struck the author, as it is recorded that while the tests of ball on ball were being carried out the search was continued



for a steel which would harden sufficiently to be used for crushing the balls without itself becoming unduly grooved. Finally a steel known to the American trade as crucible tool or file steel and a steel manufactured by the Carpenter Steel Company were selected. Balls up to and including ½ inch diameter were then tested between two pieces of this steel $1\frac{1}{2}$ inch in diameter and 1 inch long. The larger balls were tested between pieces 2 inches square and ⅞ inch thick. The indentations were very slight and were ground off after each test.

The means of the results obtained were as follows, the various manufacturers being designated by the letters, A to F.:—

Diameter of ball.	Ball on ball.					
	A.	B.	C.	D.	E.	F.
Inch.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
⅛	1,523	993	1,673	1,210	1,046	1,232
3/16	2,713	2,202	2,526	1,330	2,440	2,783
¼	4,063	4,162	4,196	3,313	4,656	4,526
5/16	6,110	5,960	5,600	5,683	7,635	7,156
⅜	7,843	6,200	8,703	7,300	6,933	13,310
½	20,966	...	17,900	...	11,273	...
⅝	23,516	...	...	...	13,646	...
1	59,033	...	...	...	...	...

Diameter of ball.	Between flat plates.					
	A.	B.	C.	D.	E.	F.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
⅛ inch	2,450	1,850	2,100	1,313	1,483	1,690
3/16 "	3,836	3,837	2,966	2,225	4,400	3,887
¼ "	8,666	5,687	5,566	6,033	6,337	7,150
5/16 "	8,993	6,887	10,883	7,733	9,275	10,200
⅜ "	14,940	14,042	10,583	10,500	12,600	13,337
½ "	41,770	...	20,883	14,833	12,966	...
⅝ "	38,866	...	...	...	21,125	...
1 "	90,650	...	...	...	...	...

From the above tables it will be evident that either the strength of steel balls varies greatly, or that the method of testing was unsatisfactory. It is curious that without exception the mean recorded crushing strength of the balls tested between plates was greater than that of balls tested ball on ball.

LEGAL.

Appleford *v.* Charing Cross and Strand Electricity Supply Corporation.

In the Chancery Division of the High Court of Justice on Wednesday, the case of Appleford *v.* the Charing Cross and Strand Electricity Supply Corporation was down for hearing. Counsel stated that there was a prospect of the parties coming to a settlement, and asked Mr. Justice Kekewich to allow the case to stand over generally in the meantime. His Lordship granted the application.

River Plate Electric Light, &c, Company.

On Wednesday Messrs. Glyn, Mills, Currie & Co. presented a petition before Mr. Justice Wright, in the Companies' Winding Court for the compulsory winding up of the River Plate Electric Light and Traction Company, Limited. On the application of counsel for the company, who stated that there was a scheme of reconstruction in hand under which all the creditors would be paid in full, the hearing was postponed until the 26th inst.

Alfred Henley & Co., Limited.

On Wednesday the petition of Messrs. Moody Brothers for the compulsory winding up of Alfred Henley & Co., Limited, came on for hearing before Mr. Justice Wright. Counsel said the petitioners were judgment creditors for the supply of electrical plant. They were also supported by another creditor. Those opposing the petition were almost equal in amount. There was a question as to the creation of a debenture for £800 immediately before the voluntary winding-up order was granted. After hearing counsel on the other side, his Lordship said there was a case for a supervision order.

BUSINESS NOTES.

Electrical Wares Exported.

Week ending June 13th, 1899.		Week Ending June 12th, 1900.	
Adelaide	Value £72	Adelaide	Value £180
Alexandria. Teleph. stores ..	116	Alexandria	178
Amsterdam	110	Amsterdam	88
Bahia	172	Auckland	83
Bombay	118	Barcelona	230
Boulogne	28	,, Teleg. wire	32
Buenos Ayres	1,325	Bombay	759
,, Teleg. mat.	242	Boulogne	16
Calcutta	170	Calcutta	407
Cape Town	1,723	Cape Town	10
Christiania	87	Casa Blanca. Teleg. mat. ..	186
Colombo	200	Copenhagen. Teleg. wire ..	71
Copenhagen. Teleg. cable ..	816	Demerara	57
Durban	1,814	Durban	437
East London	10	,, Teleg. mat.	101
Fremantle	15	Emden. Teleg. apparatus ..	1,975
Gothenburg	83	Fremantle	97
Hamburg	300	,, Teleg. wire	259
Madras	18	Gibraltar	100
Malta	89	Halifax	70
Ostend	50	Hamburg. Teleg. mat.	700
Otago	22	Hong Kong	335
Port Chalmers	75	Mauritius	86
Port Elizabeth	908	Melbourne	1,792
Rotterdam. Teleg. mat. ..	233	Ostend	701
Shanghai	170	Port Elizabeth	68
St. Petersburg. Teleg. mat. ..	156	Rouen	40
Sydney	810	St. Petersburg. Teleg. cable ..	53
Teneriffe	32	,, Teleg. cable ..	101
Trieste	11	Shanghai. 30 tons old teleg. wire	—
		Sydney	806
		Vladivostock	145
		Wellington	219
Total ..	£9,925	Total ..	£10,334

Foreign Goods Transhipped.

Colombo. Elec. supplies.	Value £90	Trinidad. Elec. apprts.	Value £30
Fremantle. Elec. goods ..	31		
Total ..	£121	Total ..	£30

Bankruptcy Proceedings.—Mr. H. Brougham, official receiver and liquidator of the Cox Thermo-Electric Company, Limited, is notifying to creditors and contributors that he intends to apply to the Board of Trade for his release. His summary of receipts and payments in respect of the company are:—Receipts, *nil*. Payments: Board of Trade and Court fees, and notices in *Gazette*, &c., £8 18s. 2d., which amount is due to the Board of Trade. The whole of the assets were sold for a sum which was insufficient to satisfy the claims of the mortgagees, and consequently the debenture holders, whose claims amounted to £10,000, received nothing in respect of their security. Certain of the directors, prior to the winding up, voluntarily offered to pay the trade creditors 13s. 4d. in the £, and this offer was renewed to the official receiver, but after protracted negotiations, the directors declined to carry it out. The receiver adds that there was nothing in the formation, promotion, or conduct of the company to justify an application for a public inquiry.

In *re* A. W. Hirst, electrical engineer, Croydon, first meeting June 21st, at Railway Approach, S.E.; public examination, July 16th, at Croydon.

At a sitting of the London Bankruptcy Court held last Wednesday before Mr. Registrar Gifford, John Henry Crawford, the promoter of the London and Provincial Electrical Company, Limited, applied to pass his public examination upon accounts showing total liabilities £25,645, of which £10,760 9s. 3d. are unsecured, and assets valued at £13,306 5s. 8d. In the course of his evidence the debtor stated that in March, 1896, he purchased for £3,000, half in cash and half in shares, the business of Messrs. Ridings, Cobb & Co., electrical engineers, of Birmingham, together with certain patents relating to an arc lamp and a secret process for the manufacture of a light metal. In June, 1897, he promoted the London and Provincial Electrical Company, Limited, with a capital of £60,000, to take over the business with larger works that he had erected in the meanwhile; also the

patents and the secret processes upon the development of which he had expended a considerable amount. The consideration to be given him as vendor was £10,000 in cash and £20,000 in shares, but no prospectus was sent out to the public, and he only received debentures for £10,000 as security for the cash consideration. He, however, received the greater number of the shares to which he was entitled. Defendant acted as managing director of the company until August, 1898, when a winding-up order was made against it. The matter remained in the hands of the liquidator until last January, when the creditors, other than himself, received 20s. in the £ on their claims, and the company was released. He now valued his debentures at par, and his shares at 5s each, and against that he had spent between £6,000 and £7,000 on the company, which expenditure was represented by existing liabilities. The company was still in existence, and had an office at 96—97, Palmerstone Buildings, E.C. The witness was cross-examined at some length regarding his other promotions, and eventually he was allowed to pass.

Agricultural Shows.—At the various agricultural shows which are being arranged at York, Spalding, Stirling, Tunbridge Wells, and Rochdale during the next month or so, Messrs. W. H. Willcox have stands at which will be exhibited their cylinder oils, Penberthy injectors, hose, pumps, driving belts, tools, and many other engineering sundries. They were also exhibitors at the Bath and Winchester shows which have just closed.

Berrenberg Lamps.—The *Contract Journal* says that the Wimbledon Council has given the contract for incandescent lamps required during a year, to the Berrenberg Lamp Company. The quantity is 5,000, and the price 1s. 5d.

Book Received.—"The Elementary Principles of Electric Lighting." By A. A. Campbell Swinton. London: Crosby Lockwood & Son. 1900. 1s. 6d.

Catalogues and Lists.—Messrs. Johnson & Phillips have made great efforts to produce a striking list of their "Ark" lamps, and they have succeeded, if rich colouring and careful arrangement count for anything, which we think they do. The firm explain in the letterpress that they have had 20 years' experience of arc lamp manufacture, and that the enclosed long burning "ark" lamp embodies all the best points in other designs. Among the notes of claims, we observe the following, under the heading of efficiency and candle-power:—"The efficiency and candle-power is at least as great as that claimed for the 'open' type lamp, namely, about 2,000 nominal candle-power per 500 watt lamp (or at the rate of four candles per watt), whilst the simplicity of parts and operation of trimming constitute a marked advance in the art of arc lighting. In an 'Ark' lamp of 5 amperes on a 110-volt circuit the tension at the arc is about 80 to 84 volts, thus about 130 to 150 watts are taken up in resistance. In a pair of 'open' type lamps of 10 amperes on the same voltage about 40 to 42 volts each are used at the arc, the remainder, about 130 to 150 watts, is used in resistance, thus the efficiency of the 'Ark,' lamp and of the 'open' type lamp is practically the same; but there is this important difference in favour of the 'Ark,' that a single lamp can be installed, where with the 'open' type, two lamps, and sometimes four, or their equivalent, would have to be used." Such subjects as quality of light, comparison with gas, and relative illuminating power are dilated upon. Some pages are devoted to globes, accessories, lamp pillars and lamp brackets. Many of the illustrations are, we understand, produced direct from photographs of the lamps, these being afterwards rendered more attractive by colour printing process. A batch of testimonials has been received from station engineers and others during the past six months or so.

Messrs. W. E. Burnand & Co., transformer manufacturers, of Ocean Works, Sheffield, send us an illustrated list of Burnand patent transformers explaining the several special features which they claim for them, and giving a variety of rough sketches of the construction showing parts.

Pamphlet No. 65 of the B.T.H. Co. describes form C.D. automatic circuit breakers for 125 and 250-volt direct current circuits.

The Columbia Telegraph Company send us some circulars of their coin slot graphophones with clockwork or electric motor.

In the summer the office man's fancy eagerly turns on thoughts of fans, and the recent sudden spell of 88° temperature in London made some wish for these cooling conveniences on the supposition that after all we are going to have some summer. Desk and ceiling fans are much in vogue in American offices where temperatures are much more extreme than here, and that they are an unspeakable boon cannot be gainsaid after experience such as we ourselves have had in these offices. The General Electric Company have prepared at an opportune moment their list of desk and ceiling fans for both continuous and alternating current for this season, and we have no doubt they will make things hum. The list is fully illustrated, and contains many details of several types with prices, &c. It is accompanied by a list of multipolar "Crocker-Wheeler" motors and generators for belt driving and direct-coupling, from 10 to 750 H.P., which also contains illustrations of complete machines and parts and full descriptive details. Either of these sections may be obtained for binding in with the General Electric Company catalogue by making application at the Queen Victoria Street offices.

The Westinghouse Companies' publishing department send us a finely got-up pamphlet describing the Westinghouse electro-pneumatic system for controlling railway and other motors as manufactured by the Westinghouse Brake Company, Limited. The system consists in the simultaneous operation from one railway car of the controllers and motors upon one or more other cars. The three systems of arrangement of apparatus for the operation of electrically fitted trains are single motor-car arrangement, multiple unit arrangement, and double motor-car arrangement. These are all described in the pamplet before us, some excellent pictures illustrating the letterpress. The special advantages of the Westinghouse system are detailed, together with a summary of results accomplished by the use of the system of multiple control in conjunction with the double motor-car arrangement of trains.

The "Lister" dynamos and motors are described in a catalogue which has come to hand from the Lister Electric Light and Power Manufacturing Company, of Dursley, Glos. First-class illustrations and certain tabulated and other information are given regarding Lister 100-volt dynamos, open and enclosed continuous current motors, combined sets for lighting and traction, motor-generators, dynamos for electro-chemical, plating, and depositing work, and multipolar type generators.

Electric Tramway Equipments.—We suppose that few English firms are so busily engaged upon electric tramway equipment contracts at the present moment as are Messrs. R. W. Blackwell & Co., Ltd. Overhead trolley work, track bonding, and the steam plant of tramway power stations have been made a special study of by Messrs. Blackwell & Dawson for many years past, that study embracing not only American practice but Continental systems as well. In fact, when there were the first heraldings of a coming stir in electric traction, the partners of this firm kept their eyes open and paved the way for the first-class business which they are now conducting. Most of us remember how the present activity was wearily waited for, while such obstacles as prejudice and other things were being cleared out of the way; and it was at these times when the question was being asked, "Are we prepared for the boom if it should come?" that Blackwell's took time by the forelock and spread out the programme which they are to-day executing. No one can deny that with the lack of knowledge that existed in this country of practical electric tramway construction and equipment, and the progress which had been already made in the States—such a concern as Blackwell's was needed to carry things successfully through the initial stages here, and few will grudge them the success which has come to them as the outcome of their timely enterprise. Up to the present the offices have been situated at 39, Victoria Street, Westminster, but the rapidly increasing business and the large office staff necessary to cope with same, has made a change to still larger premises compulsory. Hence it comes about that the firm to-morrow (Saturday) moves to more commodious premises at 59, City Road, where the offices and stores will be combined. Up to the present the stores have been at Barmondsey, but it will be a distinct advantage to have the two departments under the same roof. The reason for going to City Road is that nothing extensive and convenient enough was available around Westminster. To refer in detail to some of the various contracts now being executed:—

Liverpool.—The entire overhead equipment, car sheds, &c., have been supplied by Blackwell's for the whole of the lines which have so far been converted, and they are now executing their seventeenth contract in connection with this corporation's very extensive trolley system. The amount of work being carried out may be understood from the fact that this year the firm's Liverpool contracts amount to over £80,000. To a firm which carried out the original contract the receipt of extension orders is an important testimonial.

New sections are continually being opened on the Liverpool system, and will be so for some time to come. The trolley extension of the Liverpool Overhead Railway to Crosby, Waterloo and Seaforth, and the Bootle Corporation electric tramway are also occupying the firm's attention so far as the outside equipment is concerned.

Plymouth.—The Corporation gave the contract to Blackwell's for extensions, as recently notified in the ELECTRICAL REVIEW, because they had carried out the original work, although there was a slightly lower tender.

Birkenhead.—Work has not yet been started here by the firm, but they have just secured the contract for the outside equipment in open tender.

Nottingham.—Messrs. Blackwell have now started here upon the bonding and overhead line for the Corporation tramways.

Tynemouth.—Overhead line construction is being executed for the British Electric Traction Company.

Central London Railway.—The engines, steam piping, and so on at the Shepherd's Bush power station (now describing in our other columns) were supplied by them, also, in fact, the same part of the equipment of the Dublin (Ringsend) station recently detailed in this journal. The overhead line work in the Shepherd's Bush shunting yard are by Blackwells.

Among other contracts may be mentioned the Leeds and Dundee tramway extensions, the Devonport lines (now completing for the British Electric Traction Company), and rail bonding for Manchester.

At the Bristol new power house to which several references have already been made in our columns, the erection of engines and steam piping will be commenced at an early date, and Messrs. Blackwell will soon be occupied in a similar way at the generating station, which is being erected for working the Isle of Thanet Light Electric Railways. They have already started putting up the engines and other parts of the equipment for which they are responsible in connection with the Chiswick power house of the London United Tramways Company. At Norwich they are just completing putting up the overhead line work for the Norwich Electric Tramways Company, for which system they have also supplied all the trucks and trolleys, and have put them together. This line will shortly be ready for official opening.

An interesting contract is that received from Messrs. Harmsworth Bros. A small tramway has been laid for conveying paper to and from their mills at Gravesend; it is drawn by an electric locomotive.

In France, 12 miles of overhead line work are being carried out in Paris, and Messrs. Blackwell are completing a similar contract at Rheims.

We understand that in connection with their contracts Messrs. Blackwell are now using more English than American material.

Trade Announcements.—Messrs. Veritys, Limited, announce that, owing to the rapid increase of their business in Scotland, they are removing from Mitchell Street to 40, Bath Street, to which address all communications should be sent on and after 18th inst. The commodious showrooms, at which a large stock of all Messrs. Veritys' manufactures will be held, will be ready early in July.

Mr. W. P. Steinthal informs us that the business of his late uncle, Mr. G. A. Steinthal, will be continued by him without interruption or alteration of name at Bradford, Manchester and Harrogate, and that he will continue to have the assistance of Mr. A. F. Scott, A.M.Inst.E.E., and of Mr. Edward Steinthal, as hitherto.

ELECTRIC LIGHT AND POWER NOTES.

Aldershot.—The Board of Trade has agreed to defer the question of revoking the Council's provisional order for 12 months.

Blackburn.—Mr. A. S. Giles, electrical engineer, in his annual report of the working of the electricity department, states that the total receipts are £11,844, and the total costs £7,135. The gross profit of £4,709 is sufficient to pay the interest and sinking fund charges for the year, leaving a small balance of £19 1s. The revenue of the undertaking has increased from £7,117 in the year 1898-99 to £11,844 in the year 1899-1900, an increase of 66 per cent. The cost of generating has been reduced to 1·651. per unit. The total cost, including management and distribution, has been reduced from 2·33d. to 2·074. per unit. There is the equivalent of 46,003 8-C.P. lamps connected to the mains, and 40 small motors taking an aggregate of 109 B.H.P. from the Corporation supply. The consumers taking supply number 604. The average price obtained per unit sold is 4·04d.

Bolton.—At a meeting of the Town Council last week it was reported that the operations of the electricity works during the past year had resulted in a gross revenue of £9,493, and a profit of £5,902, as compared with £6,987 and £4,536 in the previous year. The net profit was £1,450, of which £1,000 was handed over in aid of the rates. During the year £50,000 was laid out on extensions, making the total capital expended £117,589. Continuous current has been substituted for alternating in the centre of the town, and the tramways have brought in a revenue of £1,593. In spite of the increase in cost of coal, the works cost has been reduced, and the total output has increased from 416,635 to 824,792 units.

Brierley Hill.—The Bill confirming the provisional order for the electric lighting of the district has received the Royal assent.

Clacton.—The District Council has decided to sit on its provisional order for six months.

Dalkeith.—The Burgh Commissioners have resolved to introduce electric lighting in the town.

Dartford.—The District Council has resolved to apply for the sanction of the Local Government Board to borrow a loan of £20,000 for carrying out the electric lighting scheme. Mr. Hawtayne is the consulting engineer.

Dorking.—The District Council is considering a proposal by Messrs. Edmondson's Electricity Corporation, Limited, for the transfer of its provisional order for electric lighting.

Eastbourne.—The statement of accounts of the Corporation electricity undertaking during the quarter ending March 31st, shows that in that period the revenue amounted to £3,650. The expenditure was £1,678; the gross profit made was, therefore, £1,972, of which £869 was applied to meet the bank interest on the temporary overdraft for the purchase of the undertaking, and £640 for sinking fund purposes, leaving a net profit of £462 14s. after the first three months' trading under Corporation auspices.

Eccles.—The accounts of the Town Council's electricity undertaking for the past year show a deficit on the year's working of £789, of which sum £346 is for repayment of loans. The Council is about to seek borrowing powers to cover the amount of £7,289, overspent on electricity works.

Ayr.—A report by Mr. A. J. Fuller, burgh electrical engineer, was submitted at the Council meeting on 11th inst., urging the advisability of changing the system in the centre portion of the town from a low-tension alternating current to a low tension three-wire continuous current distribution. The estimated cost of the alteration was £8,730. Disposal was delayed.

Fermoy.—Mr. Warden-Stevens has deposited £100 with the District Council as a guarantee to carry out his agreement to light the town with electricity by January next.

Glasgow.—Mr. J. Christie, station superintendent of the Corporation Electricity Department, having been appointed chief electrical engineer to the Corporation of Brighton, Mr. W. J. Poole, who has been for two years superintending the erection of the plant in Port-Dundas, has been appointed his successor at £200 per annum.

The Glasgow and South-Western Railway Company have applied to the Corporation for a supply of electricity for St. Enoch Station and other premises belonging to the company. Their annual requirement is 660,000 units. The sub-committee charged with the electric lighting has recommended that the supply be given at the same rate as to ordinary consumers at the price of 1½d. per unit.

In reply to the application by the Police Commissioners of Partick for a temporary supply of electric current to consumers within the burgh until the new works have been completed, it is recommended that the supply be granted for 12 months, from October 1st, at 3½d. per unit, the amount not at any time to exceed 250 amperes at 500 volts on the three-wire system.

Gravesend.—Electrical schemes have hung fire here year after year, and from what we read in a local paper little headway has been made. We quote:—

> Are the electric lighting and the electric traction schemes to be shelved again in Gravesend? The Corporation took the electric lighting order away from Messrs. Crompton & Co. because they delayed in carrying it out, and yet they show no sign of doing anything themselves. It is time some one woke them up. In regard to electric traction, the progress is equally slow. The successors of the Gravesend and Northfleet Tramway Company are pledged to introduce electric traction within a certain period, and the time has arrived when they should start laying down the new plant, but we see no signs of an intention to do so. In fact, it is rumoured that the scheme has been abandoned. We are glad to see that Councillor Tolhurst has called the attention of the Northfleet District Council to this state of affairs, and that they have instructed their clerk to ask the company what their intentions are in regard to the electric traction scheme.

Greenock.—The Police Board has appointed Mr. W. M. Nelson, assistant in Greenock municipal electrical department, as electrical engineer, in succession to Mr. Fedden, who has received the appointment of electric lighting engineer to the Sheffield Corporation. Mr. R. F. Mackay was next on the list.

Hamilton.—The Town Council has decided to instruct Messrs. Buchan & Hogarth, Edinburgh, to report as to the probable cost of an electric lighting scheme for the burgh.

Heywood.—The Finance Committee of the Town Council has decided to apply to the Local Government Board for permission to borrow £15,000 for the purposes of the electric light scheme. The tender of Messrs. Crompton & Co. for machinery and plant has been accepted by the Committee.

Kidderminster.—The Guardians are considering the advisability of adopting electric lighting for the Workhouse.

Kirkcaldy.—Prof. Kennedy, who has hitherto been advising the Town Council on electric lighting schemes, has now been appointed engineer to carry out the work without delay.

Leeds.—The Lighting Committee of the Leeds Corporation intends making application to the Local Government Board for sanction to borrow a further sum of £27,573 for electricity purposes.

Leamington.—The Town Council has decided to engage Mr. H. Boot, at a fee of 50 guineas and expenses, to report on the value of the Midland Electric Lighting Company's works; but no steps are to be taken by the Council to oppose the company's provisional order.

Leith.—Mr. J. Gray Scott, of Whitehaven, has been appointed resident electrical engineer in place of Mr. Bryson, resigned. The electrical engineer has reported that there were, at the end of May, 220 consumers, with 19,148 8 C.P. lamps connected, in addition to the public arc lamps. The income for 10½ months last year was £3,370, and the expenditure £2,348, showing a gross profit of £1,072. After paying capital charges there is a net deficit of £650.

Newport (Mon.).—The accounts of the electricity works show, for the first time, a surplus, amounting to £403, with a gross profit of £4,092, as the result of the past year's operations. The deficit in the previous year was £293.

Otley.—The District Council has appointed a committee to make inquiries and report upon whether a scheme for supplying electric light to the town could be made successful.

Rhyl.—The Local Government Board has approved of the scheme for lighting Rhyl with electricity. The scheme will entail an expenditure in the first instance of £19,000, and will be worked in conjunction with a refuse destructor and a new electric railway along the sea front.

St. Helens.—The Electric Supply Committee has reported to the Town Council that the net profit on the Cropper's Hill power station for 8½ months was £1,156, but that there was a deficit of £1,145 for the year on the Warrington Old Road station. The committee has resolved that it is not desirable to reopen the Warrington Old Road station.

South Shields.—The Town Council has received the sanction of the Local Government Board for a loan of £15,600 for electric lighting extensions; the Board also asks for further particulars concerning the works for which a loan of £36,750 was applied for on April 25th.

Spain.—Application has been made to the Spanish Government for a concession to utilise the water-power of the river Ottaven in the generation of electrical energy, to be used for lighting and power purposes at Redondela, and several other towns in Galicia.

Stourport.—The District Council has favourably received a proposal of the Kidderminster and District Electric Lighting and Traction Company to supply electricity to the town.

Swansea.—The Town Council has resolved to extend the electricity supply to the whole of the area of the borough, without waiting to see it proved successful in the central area. The price of supply has been fixed at 6d. first hour and 2d. afterwards for lighting, 6d. and 1½d. for motive power, or alternatively for the latter 3d. per unit all round. Applications for the post of electrical engineer, at a salary of £300 a year, are to be invited.

West Ham.—During the past half-year, a profit of £2,020 8s. 10d. has been made by the Town Council on the electric lighting of the borough.

Wolverhampton.—The past year's working of the electricity undertaking has resulted in a net profit of £402, although £912 was spent out of revenue on account of the change of pressure of supply. The latter took place under considerable difficulties, owing to the delay in completing the battery room; but the output has increased by 30 per cent. during the year, and a large number of motors have been connected with the mains, while the lamp connection has been augmented by over 26 per cent.

Wood Green.—The Urban District Council has instructed a committee to inquire into the question of electric light for the district, with a view to an early report to the Council.

Yorkshire Power Scheme.—The Dewsbury Town Council has replied to a letter from the promoters to the effect that the Corporation would not be prepared to view the proposal with favour.

The Ossett Town Council intends to oppose the above scheme so far as it affects the borough.

ELECTRIC TRACTION NOTES.

Dublin.—On 5th inst. at Dublin, in the Queen's Bench Division (Court No. 1), before the Lord Chief Baron, Mr. Justice Andrews, Mr. Justice Madden, and Mr. Justice Boyd, the question as to the liability for the sanding of the streets came up for argument on two cases stated at the instance of the Dublin United Tramways Company. The defendant company were summoned by the Dublin Corporation in two summonses for having made default in maintaining and keeping in good condition and repair with such materials as the Corporation directed, the tramway tracks within the city. On the hearing of the summonses by Mr. Swifte, divisional police magistrate, fines of £5 and £10 costs in each case were inflicted. At the hearing below a number of witnesses were examined, and on their evidence Mr. Swifte had found that the tram tracks had not been maintained and kept in good condition and repair as directed by the Corporation, and had become, through their slipperiness, a danger and annoyance to the ordinary traffic. He also found that the main cause of this dangerous slipperiness was the condition of the weather at certain periods, particularly when it was, or had been, for some time very dry, or when it had been for some time what is popularly called "muggy." Another cause, though a much less effective one, was in dry weather, what one witness described as the "swishing" or brushing away of the particles of grit, gravel, or dust lying on the tram tracks, which particles, if permitted to remain there, would afford a certain amount of foothold to horses hoofs, but which were "swished" away by the draught produced in the transit of the electric cars over the tramways at a high rate of speed. He further found that, to a very small extent, the slipperiness was caused by the "setts," or stones, forming the tram track requiring to be "re-dressed," that is, taken up, re-trimmed on the upper surface, and laid down again. He found, however, that the defendants had made reasonable efforts to keep the tram tracks "re-dressed" from time to time, and that their structural condition was fairly satisfactory. This latter was the only question of fact substantially controverted in the case, and he thus found it in favour of the defendants. The proper remedy for the slipperiness complained of was, in his worship's opinion, the sanding of the tram tracks. The arguments were being heard on 6th inst.

Dudley and Sedgley.—The reconstruction and equipment of the Sedgley, Upper Gornal, and Dudley lines of tramway for the purposes of electric traction for some time proceeded very slowly, but recently the British Electric Traction Company have put a large number of additional men on the work, and it is now so far advanced that it is hoped the route will be open for traffic in the last week in July. The traffic on the line, it should be stated, has been entirely suspended during reconstruction.

Gateshead.—The laying of the permanent way for the electric tramways was to commence this week.

Hamilton.—The Town Council has withdrawn its opposition to the Hamilton Electric Tramway Bill on receiving an additional £1,500, making £11,500 in all for street improvements on the proposed route.

Hull.—There was a discussion in the Council last week respecting certain breakdowns which had occurred at the tramways power station. It was explained that a negligent workman had been removed, and a third engine has been provided, and this would be available in the event of mishap, so that the town could feel fairly safe.

Kirkcaldy.—Prof. Kennedy, who has hitherto been advising the Town Council regarding the tramway and electric lighting schemes, has now been appointed engineer to carry out the work.

Leeds.—Mr. G. A. FitzGerald and Colonel Boughey, two of the Light Railway Commissioners, held an inquiry at the Town Hall on 7th inst. with reference to the applications made by the British Electric Traction Company, Limited, for powers to construct lines in various districts of the West Riding. The proceedings were practically concerned with two schemes, in the first of which Bradford, Drighlington, Gildersome, Morley, and East and West Ardsley were affected. With the exception of Bradford, all these places were in agreement in supporting the proposals of the promoters. The second scheme embraced an extension of the powers which the company obtained some months ago for the construction of tramways, or light railways, in the Spen Valley. It will be remembered that at the first inquiry the Commissioners pronounced in favour of the company, despite the opposition of the local authorities regarding what was known as the Spen Valley, Dewsbury, and Ravensthorpe tramways. Power was now sought to construct a branch from near Cleckheaton to Hightown, and to extend the projected line to Dewsbury through Savile Town, Thornhill Lees, and Thornhill, to that part of the township known as Combs. The opposition in regard to the proposed extension of the Spen Valley scheme came wholly from Batley, the Corporation of that borough r senting any interference with the powers they are seeking to obtain, sanctioned by the Board of Trade, and now before Parliament, for the construction of a tramway which, for two-thirds of the route, is identical with that which the promoters of the private concern have in view.

After a lengthy hearing the decision of the Commissioners was given as follows by Mr. Fitzgerald:—In the case of the Morley and District Light Railway they were prepared to recommend the granting of the order, with the exception of the portion within the borough of Bradford, and subject to the proviso that if within two or three years of the confirmation of the order the Bradford Corporation extended their system of tramways to the cross roads at Drighlington, the powers of the company to construct a corresponding portion of the line should not be operative. In the case of the Spen Valley extensions, the Commissioners were prepared to recommend the order for the whole of the lines outside the borough of Batley, subject to a proviso, as regarded the portion in Hunsworth and the part in Birkenshaw, that if the Bradford Corporation obtained Parliamentary powers to make a line from that point, and work it within a certain period, the powers of the company as regarded that portion should not be operative. As to Batley, the Commissioners felt that the fair and right thing to do was not to stop the application of the company altogether, but to leave it to Parliament to decide upon the whole scheme. What the Commissioners proposed to do was to recommend an order, subject to a proviso, that if the Corporation's order was confirmed by Parliament, the company should not exercise any powers with regard to the line within the borough. They also thought that the short line, No. 9, should be omitted from their draft order.

On 6th inst. a regular service of electric tramcars was instituted on the York Road route, Leeds.

Norwich.—The bye-laws and regulations proposed by the Norwich Electric Tramways Company are printed in the *London Gazette* for June 12th.

Old Hill and Cradley Heath.—In consequence of the rapid progress which has been recently made with the construction of the tramways in these districts, the British Electric Traction Company hope to have the lines completed for the Board of Trade inspector by the third week of July.

TELEGRAPH AND TELEPHONE NOTES.

Sunderland Telephones.—Important changes are about to take place in the telephone system at Sunderland. About three years ago, says the *Yorkshire Post*, the National Telephone Company decided to do away with the overhead wires in that town, and to replace them by the "metallic" circuit of dry core cables. A local contractor was entrusted with the work, which reached a practical completion some time ago, about 30,000 yards of ducts having been laid. The process of drawing in the cables is now being executed, and already a length of 2,000 miles of copper wire has been placed in position underground, and it is expected that the first section of the new system will be in operation this week.

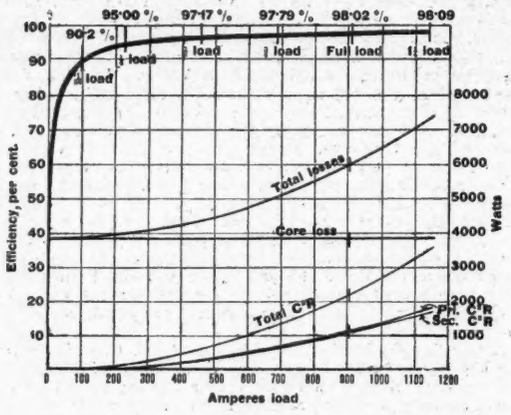
The Telegraph Wire Export Trade.—An unprecedented active state of affairs is just now prevailing in the export trade of this country in telegraph wire and apparatus connected therewith. The shipments last month reached a value of £395,808, which compares with £257,089 in April last, and only £31,377 in May, 1899. The activity which is prevailing in this branch of trade is much more clearly indicated by the returns for the five months ending with May last, these showing a value of no less than £1,411,716, as against only £473,856 in the corresponding period of last year, and £355,615 in the first five months of 1898.

(*Continued on page* 1019.)

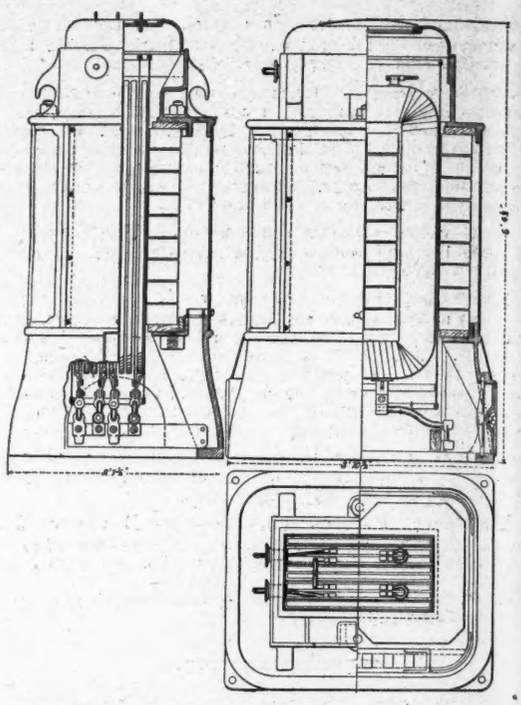
CENTRAL LONDON RAILWAY.

(*Continued from page* 975.)

THE rotary converter sub-stations form a unique feature in electric railway working, alike from their position, their immense power capacity, and their purpose.



300-KW. TRANSFORMER: EFFICIENCY AND LOSSES.



300-KW. TRANSFORMER: SECTIONAL ELEVATIONS AND PLAN.

They are situated in the base of the lift shafts below the level of the platforms, and are, therefore, at a depth of about 127 feet beneath the street surface; at Notting Hill Gate the whole of the equipment is contained in a chamber 30 feet diameter and 21 feet high, but at Marble Arch and the Post Office the plant is divided between two chambers, each 23 feet diameter by 15 feet high.

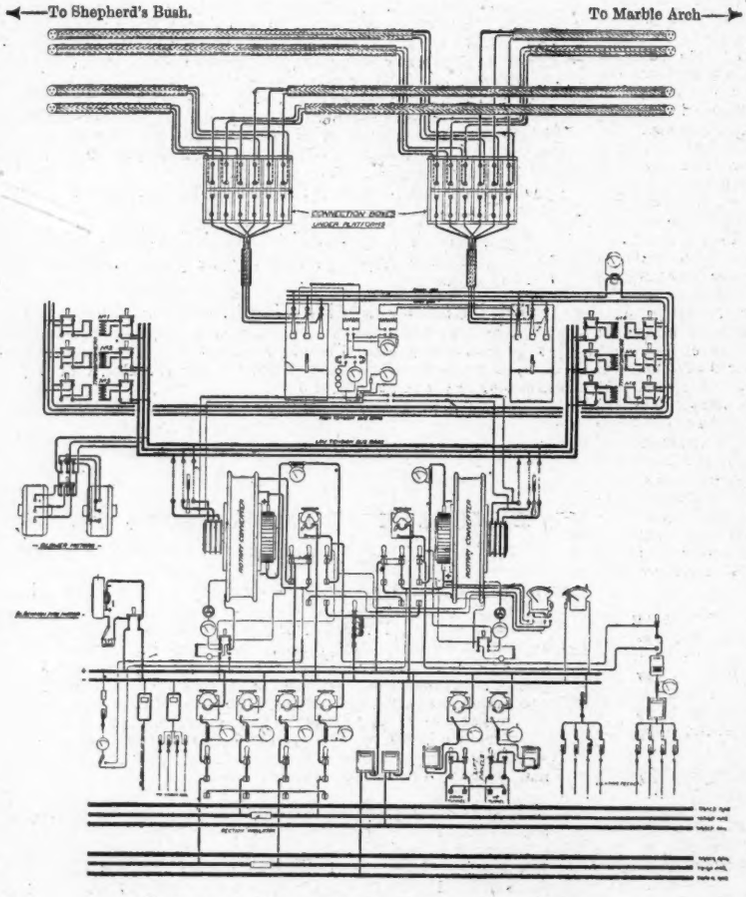


DIAGRAM OF CONNECTIONS AT NOTTING HILL GATE.

The normal maximum output of each sub-station is 1,800 KW., but this could be increased on occasion by 20 per cent. without any difficulty.

Lastly, these are, we believe, the only three-phase rotary converter sub-stations for underground electric railway working in existence.

The plant in each case consists of seven transformers, two rotary converters, and the necessary switchboards, blowers, &c. A novel kind of radial overhead crane, consisting of girders pivotted to the centre of the roof, and supported by wheels running on a circular rail at the circumference, provides for the ready handling of the machinery at Notting Hill Gate; part of this is visible in our view of the main switchboard. The two converters and the bank of transformers form three sides of a square, from the open side of which a ladder leads to the switch board gallery; this extends halfway round the room at a height of 6 feet 5 inches from the floor level.

We give a diagram showing the general arrangement of the connections at the Notting Hill Gate sub-station. From the connection boxes, one in each tunnel, two high tension feeder cables enter the room and pass through Parshall three-phase switches to the high tension bus bars which are mounted above the A.C. panels of the switchboard. An ammeter transformer, similar to those at the power station, is mounted on one of the bars to indicate the total current entering the sub-station; a view of this instrument is given, which also shows the method of supporting the bars. Another view shows the back of the high tension panels, with the Parshall switch gear and voltmeter transformers, as it appeared when erected at the maker's works. Passing over a space in front of the ventilating trunk, the H.T. bus bars bring the three-phase currents to three transformer

panels, each of which is fitted with double-pole switches for the primary and secondary circuits of two transformers. Each of the latter has a rated output of 300 KW. at a pressure of 330 volts on the secondary side, when supplied at 5,000 volts, so that the secondary current is about 900 or 1,000 amperes. The transformers are coupled up in delta fashion on both high and low tension sides. We give a view of the bank of transformers in place, as well as part sectional drawings showing their internal construction. It will be seen that the coils are supported in a vertical position, with a horizontal core in the form of a double magnetic circuit.

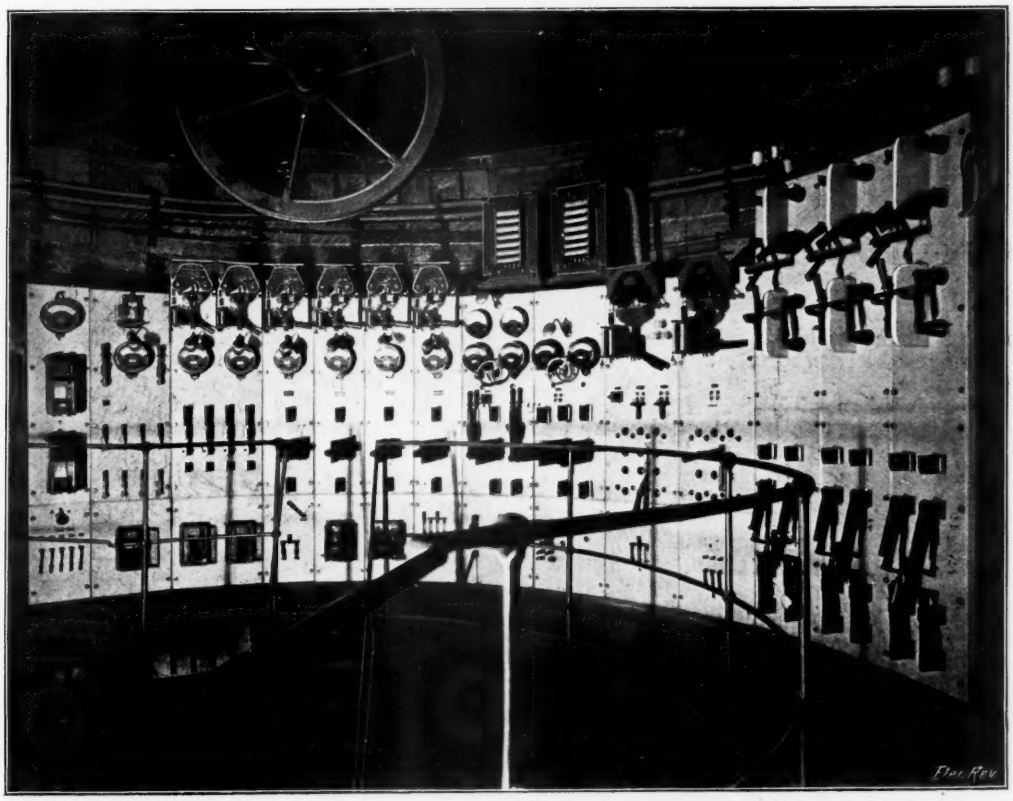
The core is built up of steel laminæ 0·014 inch thick, separately japanned, with ventilating ducts at frequent intervals; the steel is of special quality, having high permeability and low hysteresis losses, and entire freedom under the conditions of service from deterioration due to ageing. The coils are wound on formers, in four primary and four secondary sections, arranged in series as shown in the plan; earth shields are placed between the high and low tension coils. The transformers are cooled by an air blast, air being drawn through ducts between the coils and in the core; dampers are provided to regulate the draught by either path. There are two blowers made by the Buffalo Forge Company and driven by three-phase induction motors of 6 HP. each, with squirrel cage rotors; these exhaust the air from a trunk beneath the transformers, to which the case of each is connected. The blowers may be used singly or together, but one is generally sufficient.

The six transformers are so connected with the switchboard that any or all of them may be used, and a spare transformer is held in reserve to replace any that may require inspection or repair. As will be seen from the curves which we reproduce, the efficiency is very high and well sustained, being 95 per cent. at $\frac{1}{4}$ load, and over 98 per cent. at full load; the analysis of the various losses is given with the efficiency curve.

From the secondary switches of the transformers, three heavy bus bars carry the current to the converter panels. These are fitted with two Samuelson three-phase quick-break switches, connected at the top with the bus bars, and at the bottom with the leads to the A.C. side of the rotary converters. As these switches have to break 2,000 amperes at 330 volts on each blade, they are of very massive construction, and the phases are separated from one another by slabs of marble to prevent arcing.

Following the course of the current, we now come to the rotary converters. These machines are the largest ever constructed for railway service, being rated at 900 KW. output, 1,800 amperes at 500 volts. Considering their large output they are remarkably small, their overall dimensions being 11 feet 8 inches by 9 feet 10 inches by 9 feet 9½ inches high. They are 12 polar, and being fed with three-phase currents at 25 periods per second, they run at 250 revolutions per minute. The normal potential difference between the collector rings is 330 volts.

In addition to a photograph of one of the machines in position, we give a plan and sectional elevations showing their construction. The base is formed of a single iron casting supporting the bearings, magnet frame, and collector gear; the frame is of mild cast steel, to which the laminated steel magnet cores are bolted. The coils are wound on sheet iron spools with brass flanges; the shunt coil, of No. 11 B. & S., 912 turns per spool, is wound next to the yoke, and the series coil, of eight copper strips 2·5 inches by 0·075 inch in parallel, 2½ turns per spool, is close to the pole-pieces. The effect of compounding on a rotary converter is very interesting. Nominally, the ratio of conversion from A.C. to D.C. is invariable; but by causing the alternating current to lead or lag over the impressed E.M.F., it is possible to vary the effective pressure between the collector rings, so as to raise or lower the voltage on the commutator. For this purpose the armatures of the generators and rotaries, and the windings of the static transformers, possess sufficient reactance, and the series winding on the rotary has the effect of over-exciting the fields, causing the current to lead in phase, so that as the load increases the D.C. voltage rises correspondingly. By suitably shunting the series winding, the compounding of the rotaries may be adjusted to give quite constant pressure under the widest variations of load.



NOTTING HILL GATE SUB-STATION.—MAIN SWITCHBOARD.

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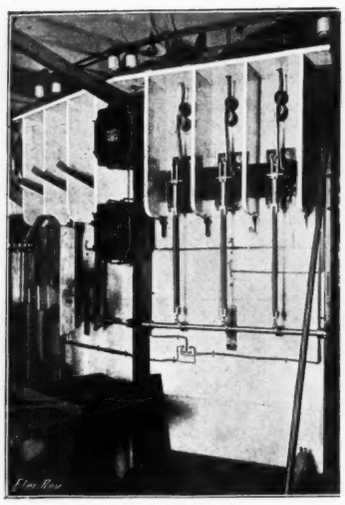
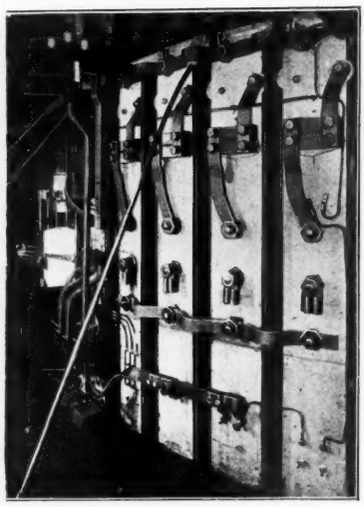
The magnet cores are 12 inches square overall, with a polar arc of 15⅞ inches on an internal diameter of 84·375 inches; the induction density in the cores is 95,000 lines per square inch, while in the yoke, which is 22 inches wide, the density is 48,000.



H.T. Feeder Panels.



L.T. Feeder Panels.

Back View of Switchboard.

The magnet frame can be bodily slid along the bed plate so as to completely expose the armature and field-magnet windings.

The armature is built up of insulated sheet steel laminæ 0·014 inch thick, secured by dovetailing to a heavy cast-iron spider.

The overall diameter of the armature is 7 feet, and the inside diameter of the core 5 feet 2 inches; the gross length of the core is 12·5 inches. There are 288 slots, each 1·25 inches deep × 0·44 inch wide; the induction density in the teeth is 128,000 lines per square inch, and in the core itself 51,000 lines.

The armature is of the drum type, multiple wound with bar conductors; there are four of these in each slot, measuring 0·4 × 0·125 inch each.

The three collector rings are joined with the armature winding at 18 equi-distant points; the rings are 24 inches diameter by 3½ inches wide, mounted on a separate spider, and there are eight copper brushes to each ring.

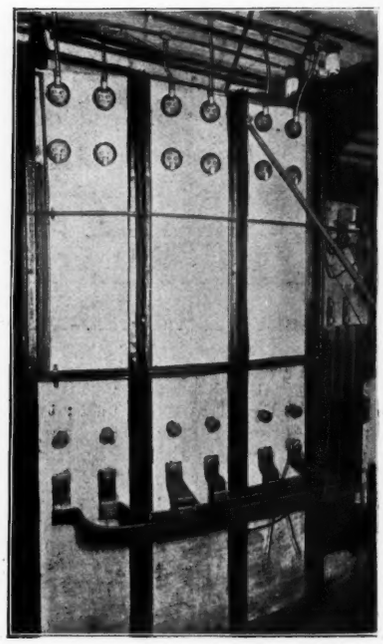
The commutator is 54 inches diameter by 17½ inches long, and consists of 576 segments, carried on a cast-iron spider. There are 12 sets of carbon brushes, eight blocks, 1¼ inches wide by ¾ inch thick, forming a set; these are carried by a cast-iron ring supported by brackets from the yoke, and can be adjusted simultaneously by a handwheel and worm—though, in actual working, the brushes remain at the mechanically neutral point, whatever the load.

The armature core weighs 7,000 lbs., and the copper 721 lbs.; the total weight is 24,800 lbs. The magnet frame weighs complete 19,550 lbs., and the whole machine 48,350 lbs.

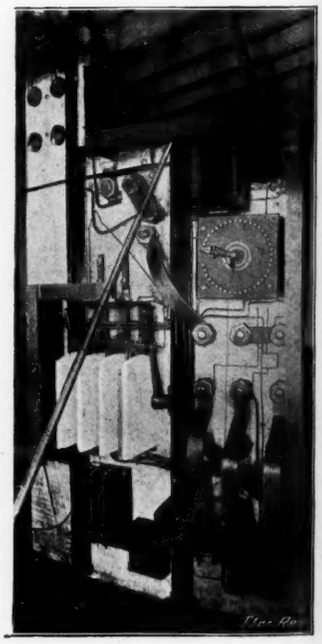
The curves relating to these machines are of special interest; the overall efficiency, it will be seen, is 95 per cent. at full and overload, and 92½ per cent. at half load; it is not probable that the average load will fall below the latter value. On the same curve are shown the detailed losses, which afford an interesting comparison with those given for the generators last week.

The magnetisation curve, which is given in terms of both A.C. and D.C. volts, shows the relation between these to be about 0·6 : 1 at practically all values of the magnetisation; while the "phase characteristic" shows the great importance of accurately ascertaining the most suitable value of the field excitation, so as to obtain the best possible power factor. With an exciting current of 6·4 amperes in the shunt winding, the "apparent" power factor on no load is over 0·7, and at all times when working on a load this value is exceeded; it may of course be brought up to unity by suitable excitation when loaded.

The method of starting is as follows:—The first rotary must, of course, be run up on the alternating current side; three transformers are switched on, and the negative of the rotary. All other switches are left open, including special switches which divide the shunt winding into four short sections, so as to avoid the induction of an excessive E.M.F. in these coils. The high tension feeder switch and the three-phase rotary switch are then closed in succession, and the rotary starts up with about 2,000 amperes per collector ring. Full speed is reached in 30 seconds. When synchronism is practically attained, the field circuit is closed, care being taken to do this when the direct current E.M.F. is building up in the right direction, as shown by the voltmeter. If, however, the polarity is wrong, a fresh start may be made or the second rotary run up; if this also has the wrong polarity, one may be reversed from the other by means of the reversing field switch. Another method is to close all the necessary switches before the engine starts, and run up slowly. When one rotary is running all the others can be started as D.C. motors from the line. For this purpose the equaliser switch is thrown down and the circuit breaker and field switch closed; this excites the field of the in-coming machine. The negative switch is then thrown downwards and the starting rheostat closed step by



Transformer Panels.



Converter Panels.

Back View of Switchboard.

step. The speed is then adjusted to synchronism, and the three-phase rotary switch closed, after which the D.C. switches are opened, leaving the converter running as a synchronous motor. The D.C. side is then paralleled with the line in the usual way.

Again following the current back to the switchboard, we arrive at the direct current apparatus. There are two panels, one for each rotary, on which are mounted the positive, equaliser, and negative switches. By throwing up the equaliser switch, the positive brush ring is coupled direct to the positive bus bar, the converter then running as a shunt machine; when it is thrown down, the brush ring is connected with the equaliser bar for compound parallel running. When the negative switch is thrown upwards the machine is coupled with the negative bus bar through the circuit breaker, which is mounted above the corresponding three-phase switch; the downward position couples the negative terminal with the negative bus bar through the starting rheostat. A Weston ammeter is fixed on each panel, as well as a double-pole reversing field switch and reversible field ammeter, and rheostat hand-wheel.

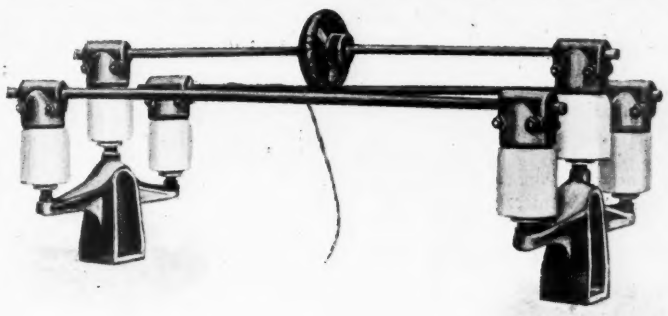
A single four-point starting rheostat is mounted on one of the panels coupled between the lower terminals of the negative main switches and the negative bus bar. An A.C. voltmeter is provided which can be connected with the collector rings of either machine, as well as a synchronising voltmeter and lamps.

The four feeder panels are fitted with circuit breakers and double-throw quick-break switches, as well as a Weston ammeter to each feeder. The third rail in each tunnel is cut by a section insulator near each sub-station, and the four ends are connected by feeders with the middle points of the feeder switches; these are arranged in pairs, two for the "up" tunnel and two for the "down." The lower contacts of each pair are coupled together by a short bar, so that when both switches are down, the third rail is electrically continuous and independent of the sub-station, and can be fed right through by the other sub-stations. In the upward position the switches couple the positive bus with the third rail direct.

The negative bus bar is permanently connected with the track rails, and the total energy supplied to each tunnel is separately recorded by two Thomson watt-hour meters.

On the base of the feeder panels are mounted two 3-phase switches controlling the blower motors, and a D.P. switch and starting rheostat for a series-wound Blackman fan motor, by means of which the sub-station is ventilated.

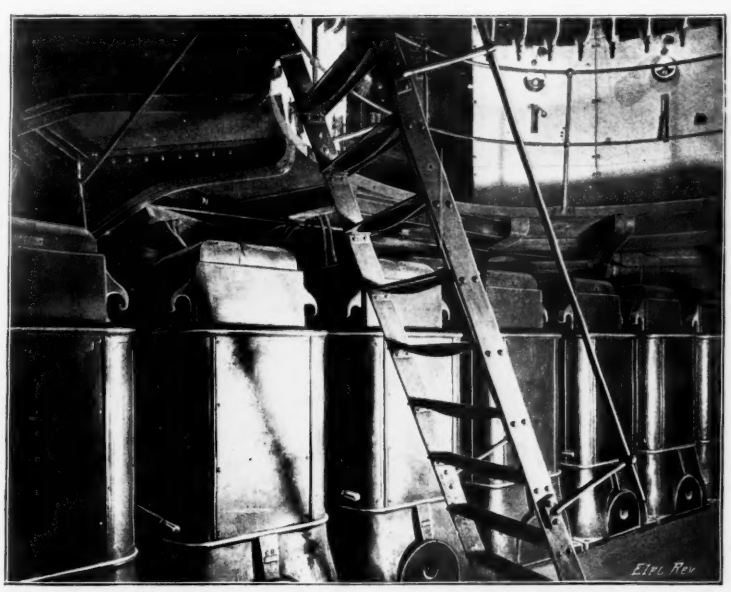
The next panel bears the apparatus for controlling the lift cables; there are two of these running the whole length of the line, one in each tunnel. These are arranged on the same plan as the third rails, in that by throwing down the switches the cables are coupled through and are independent of the station; while by throwing them upwards, they are connected with the positive bus bar. The current to the two "up" cables is passed through an ammeter and a watt-hour meter, and through one circuit-breaker; the same holds good for the "down" cables. The ammeter reads both sides of zero, so as to show the current restored to the line by the lift motors acting as brakes.



Arrangement of H.T. Bus Bars and Ammeter Transformer.

The lighting feeders are entirely separate from the power circuits; a positive and a negative feeder for this purpose run the whole length of each tunnel, and the distributing boards in each station are coupled with these on the three-wire system. The lighting feeders are connected with the + and — bus bars in each sub-station, and with several storage batteries at different points on the line. The lighting panel, next to the lift panels, is fitted with a minimum current cut-out to prevent the batteries from feeding back into the machine; when this comes out, the lighting load is thrown entirely on the batteries, which also carry the load when the line is shut down. There is a positive main switch on this panel by means of which the positive lighting bus bar is coupled to the positive main bus bar, while the negative main switch is double-throw, to connect the negative lighting bus bar direct with the negative of either rotary, so that the lighting is unaffected by the circuit breaker. A main ammeter and a watt-hour meter are also provided for the lighting circuits.

The remaining panel of the switchboard is fitted with various instruments by Weston & Elliott Bros. for testing the leakage from the third rail, the drop in the track rails, and the total return by earth to the sub-station.



Notting Hill Gate Sub-station.—Bank of 300 kw. Transformers.

One of our views shows the whole of the switchboard at Notting Hill Gate except the high tension feeder panels; other views show the backs of similar boards.

The number of safeguards against breakdown provided by the arrangement described is worthy of note; the sub-station can be supplied with power by either or both feeders from the power station; the transformers and converters are in duplicate, and can be worked in various combinations; the connections with the line and the lift cables are also arranged so as to give the maximum number of alternatives, and the storage batteries ensure that, whatever might happen to the line, the lighting would be unaffected. That these advantages should have been attained in the

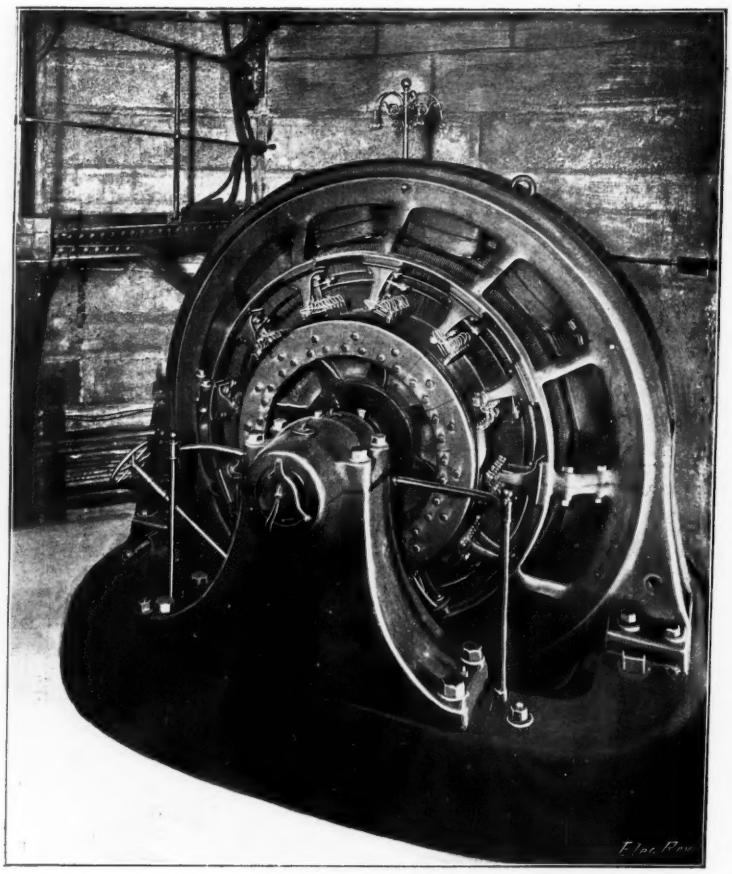
teeth of the difficulties consequent on the small space available and the unique conditions of working, reflects the greatest credit on the designers of the system.

(*To be continued.*)

REVIEWS.

Therapeutic Electricity and Practical Muscle Testing. By W. S. Hedley, M.D., M.R.C.S. London: J. and A. Churchill. 1899.

Though electricity is by no means yet the panacea for the cure of all diseases which the advertising quacks would have us believe, steady progress is being made in its scientific application in medicine. This work of Dr. Hedley's gives us an excellent account of what has been done up to date. In one department, namely, electro-diagnosis, great advances appear to have been made. By applying electric currents to definite muscles and nerves, diseases of these structures can be detected and identified. In making this examination, tests are made separately with the cathode and with the anode, and the results of opening and closing the circuit are noted. The minimum current required to produce muscular contraction, is generally different in all these cases, and the degree of sensibility is very different in the healthy and in the diseased conditions.



Notting Hill Gate Sub-station.—900 kw. Rotary Converter.

Careful instructions for the treatment of a great variety of diseases are given by Dr. Hedley. In some cases the results obtained are pretty reliable; but many reported cures of otherwise incurable diseases must, we fear, still be received with a considerable amount of reserve.

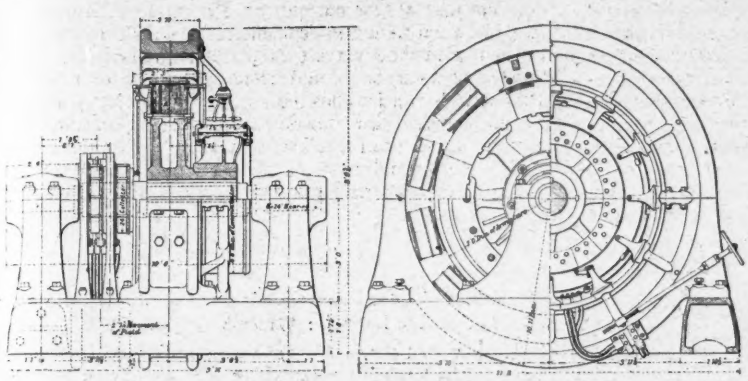
In electro-medical treatment, a great deal depends on the exact nature or configuration of the current which is applied. This generally depends on the source from which it is obtained, though not necessarily so. The current may be obtained from a battery, from the street mains, from an induction coil, from a Tesla coil, &c. The medical man of the past apparently considered that the nature of his current was completely determined by its source, and was accustomed to speak of the faradic current, franklinisation, voltaisation, and even d'arsonvalisation. Dr. Hedley admits that this nomenclature is defective, and yet he retains it. We cannot help thinking that this retention of obsolete terms has helped to retard the progress of medical electricity, and in many cases prevented medical men from acquiring clear conceptions of the mathematics of the electric current.

This work of Dr. Hedley's is not altogether free from this defect. His explanations of the action of the induction coil are by no means clear, and in some points, if we understand him rightly, incorrect. He says (p. 33): "An E.M.F. of a dis-symmetrical type is produced by various forms of apparatus, of which the medical induction coil is the chief. Here the E.M.F. of the break current is much greater than that of make, but the quantity of electricity in each case is the same, *i.e.*, the area of the surface $a\ b\ c = d\ e\ f$, but in the latter the current passes in a shorter time." Now, in this passage there are several expressions which grate on the ear of the physical electrician, and ought equally to grate on the ear of the physiological electrician. In the first place, the product of E.M.F. into time cannot be equal to a quantity of electricity; it is the *quantity*, not the *current* which passes in a shorter time. It is not clear whether Dr. Hedley means that the current as well as the E.M.F. of a coil is of the alternating dis-symmetrical type (and the current appears in electro-medical work to be the more important). Now, except when the external resistance is comparatively low, the current of an induction coil secondary is not alternating, but unidirectional and intermittent. Again (p. 42) we find: "For a given primary and secondary circuit we can increase the E.M.F. by increasing the current in the primary, thereby increasing the magnetic flux, or by increasing the frequency with which the current is made or broken." The first part of the statement is correct if by the current in the primary we mean the *maximum* current; but the second part, is, to say the least, misleading. The length of spark, *i.e.*, the E.M.F. obtained from a good coil, is the same for one break per second as for 100 breaks per second. The only effect of increasing the frequency of the breaks will be to increase the frequency of the sparks. The explanation of the action of the influence machine which Dr. Hedley quotes from Knott is obscure, but, in so far as we understand it, it appears to be incomplete and incorrect.

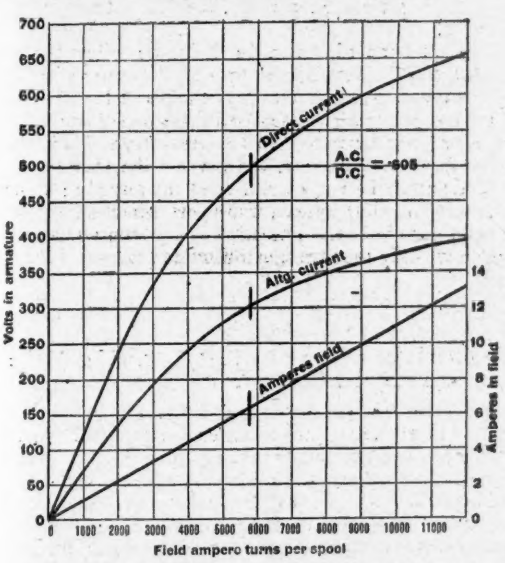
It seems also of the greatest importance for medical electricians to ascertain the exact profile of the gradients of the currents with which they deal. This may be approximately got at from theoretical considerations involving a considerable knowledge of the mathematics of electricity: but the only reliable method is to use some form of instrument which will draw the current gradient of rapidly varying currents, such as the beam of cathode rays in the Braun tube. A more exact knowledge of the generators of electricity and the properties of the electric current appears to be a desideratum amongst electro-medical practitioners. Otherwise we should not expect to find the blemishes we have pointed out in the work of so high an authority on this subject as Dr. Hedley.

Polyphase Electric Currents and Alternate Current Motors. By SILVANUS P. THOMPSON, D.Sc, B.A., F.R.S. London: E. & F. N. Spon, Limited, 125, Strand. 1900.

This is the second and enlarged edition of the author's previous work on the subject. Prof. Thompson is happy in having had a large experience in issuing new editions of his various works, and evidence of such experience pervades the whole of the book. The advent of a new edition of a treatise on alternating currents necessarily involves considerable labour on account of the rapid advances made in the subject, both in new and improved machinery and apparatus, and in extensions and simplifications of the theoretical treatment. Much has been done, and more remains to be done. The subject teems with fertile fields for skilled and ingenious investigators. The difficulty of obtaining information in a collected and readable form has been an obstacle to the advancement of alternating currents and of their commercial application. The subject is naturally and inherently difficult, and taxes the intelligence of the electrical engineer quite enough even when placed before him in the simplest possible manner. Prof. Thompson recognises this, and not only couches his statements in that simple yet forcible style of his, but also, in the present book, has taken great pains to make his drawings and diagrams as clear as possible.



CENTRAL LONDON RAILWAY.—900 KW. ROTARY CONVERTER.



CENTRAL LONDON RAILWAY.—MAGNETISATION CURVE.

It is often tedious and wearisome tracing the windings of multiple circuit armatures, but the author has overcome this objection by printing the various circuits in different colours. The rotor windings are thus greatly simplified, for not only are the various circuits easily distinguishable, but each individual circuit can be traced at a glance. The book would have been further improved with similarly coloured stator windings. There is much new matter on induction motors, rotary converters and frequency transformers, while there are new chapters on polyphase equipment of factories, distribution of polyphase currents from central stations, and polyphase electric railways. The enlarged chapter on design of induction motors should be invaluable to the practical designer.

In an appendix on alternate current calculations, the method of vector algebra is very clearly explained, but it is doubtful whether the horizontal and vertical bar notation is an improvement. Too many notations lead to trouble, disgust and despair.

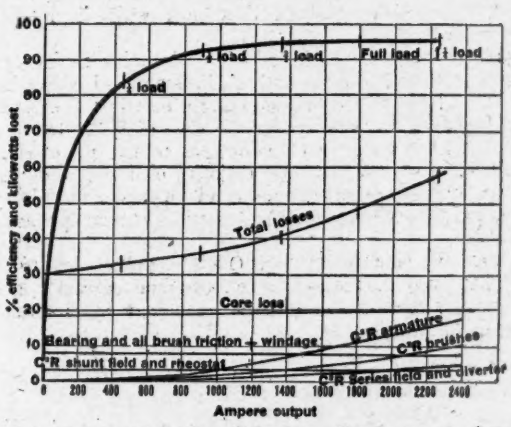
At the end of the book is given a series of working drawings of generators and motors which forms a valuable addition.

The author has, in a second edition, succeeded in producing a treatise on polyphase currents which equals, if it does not excel, his other publications, although they have run through many editions.

As we have previously remarked, the subject is bristling with difficulties, and is far from perfection or finality. The object of teachers and writers should not be merely to describe what has already been done, but to cultivate independent thought on the part of their students and readers by careful physical explanation of the various phenomena, by pointing out defects in existing machinery, and by indicating possible means of improvement. Perhaps, in the third edition, which will come soon if the second meets with the demand it merits, the author will supplement the chapter "Hints on Design" by "Hints on Improvements."

Standard Polyphase Apparatus and Systems. By MAURICE A. OUDIN, M.S., Mem.Am.Inst.E.E. London: Sampson Low, Marston & Co., Limited, Fetter Lane, Fleet Street, E.C. 1900.

The slow but steady way in which alternating currents are forcing themselves before the notice of the electrical public, on account of their electrical and commercial superiority over continuous currents for certain classes of work, is every day becoming more evident, and the need is consequently felt of a book or pamphlet containing descriptive information and tabulated data of the various alternating current machines and apparatus required in the construction of any plant. There are many such books dealing with continuous current working in a fairly exhaustive manner, but no one has yet ventured to incorporate alternating current matter or to produce a separate publication answering the requirements of the engineer and artisan engaged in alternate current working.



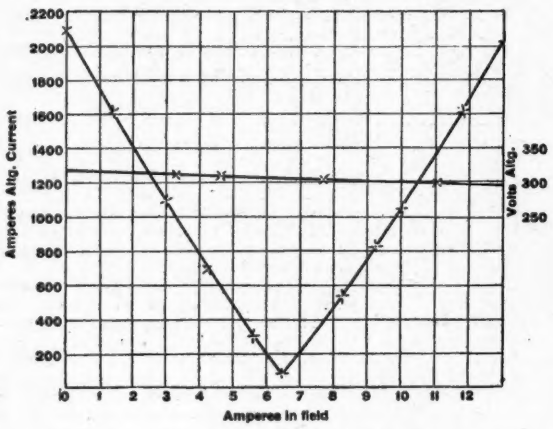
CENTRAL LONDON RAILWAY.—CONVERTER EFFICIENCY AND LOSSES.

The publication under review is, according to the preface, an attempt to provide "information, in a convenient form, on the characteristics and uses of the various types of polyphase apparatus, and on the actual working of the several polyphase systems now sanctioned by the best practice. These notes are intended for electrical engineers, central station men, and others who talk about, operate, or are

interested in polyphase machinery. While a certain general acquaintance with alternating current apparatus is presupposed on the part of the reader, the author believes that the reader whose experience has been confined to direct current machinery, will, nevertheless, experience no great difficulty in reading and understanding this book."

The first 16 pages of the book are devoted to a *statement* of the various terms used in alternating currents, with a view to assist the reader to understand the subsequent matter, which deals with generators, induction motors, synchronous motors, rotary converters, static transformers, station equipment and general apparatus, the various systems, choice of frequency, and calculation of transmission lines.

The general description is excellent, and the last chapter, dealing with the calculation of transmission lines, should



Central London Railway.—Phase Characteristic of Rotary Converter.

be very useful, more especially as illustrative numerical examples are worked out, and the necessary tables and curves given. Throughout the book the illustrations are good, and the diagrams clearly and accurately drawn. In the instance of the reviewer's copy the binding is not good, which is a drawback to a book which is intended for constant use.

On the whole the book furnishes admirable reading, and one is impressed with the author's intimate and comprehensive knowledge of the subject, but we scarcely think that it will become a *sine qua non* for the class of reader for whom it is intended. With all due respect to the profession, it must be admitted that the majority of those who "talk about, operate, or are interested in polyphase machinery," have not been educated to *think about* it in a comprehensive fashion.

We can recommend Mr. Oudin's production to the managers and chief assistants of alternating current stations, and assure them that in it they will find much interesting and useful information.

Leçons d'Electrotechnique générale professées à l'école supérieure d'Electricité. Par P. Janet. Paris: Gauthiers-Villars. 1900.

The study of electricity tends continually to division into two sections. The nature of electrical and magnetic stresses in the ether, and their action upon matter through electrical charges, electrical currents, and magnetic poles, is coming to be regarded as a separate educational subject from the electrical properties of matter, much as dynamics is separated from machine design, or the strength of materials. This book deals with the second section, with the theory of the properties of electrical machinery; and with the exception of a few chapters at the beginning on Ohm's law, hysteresis, and on magnetic screens, and of two chapters on harmonic functions and alternating currents, is entirely devoted to dynamos, motors and transformers. The treatment is theoretical throughout, and the illustrations are all diagrammatic. Mathematical symbols are freely used, but only simple operations. M. Janet's style is lucid and attractive, and the treatment, without any particular attempt at profundity or originality, is so fresh that the book is interesting reading, even where the matter is most familiar. M. Janet is, we should think, a very good lecturer. The book is an excellent example of that curious French talent for writing treatises, in which we are so deficient. It is a large octavo, in the usual good style of these French publications. After nearly every chapter is a bibliographical list of articles in French technical journals dealing with its subject. By their liberal reproductions and translations of foreign writers, these journals do for the French student some of the work which *Science Abstracts* does for us. Those who make a practice of keeping in touch with foreign publications will find this book repay attention.

English and American Lathes. By J. G. Horner, A.M.I.M.E. London: Whittaker & Co. 1900.

We have not the pleasure of the author's acquaintance, but he must be a terribly painstaking man to have written this large book of 160 large quarto pages, and to have done so in such minute detail. In it the reader will be instructed in the differences that characterise the practice of the two countries. He will find the lathe traced from its development through the paths of shop practice to the very highest results. To those not immediately connected with the use of lathes or their manufacture, the study of this book presents, perhaps, little of attractiveness. The engineer may find an interest in it by reason of the attention given to the following up of an idea, and the solution of mechanical problems along different lines to the same end.

Stated briefly, a lathe is a machine by which cylinders are to be turned, and the lathe has been developed into a machine to face discs by the addition of cross slides. From these two simple motions all other motions are developed, and the manner and method of this development form the subject matter of the book. The treatment is largely historical, though essentially practical. The author has an open mind for the virtues and vices of both English and American types and details. To speak of an American lathe having vices is, perhaps, a little dangerous at the moment!

It is quite an education in design to follow the author through this book, and take up with him some small detail, say the question of the coned or the parallel neck, the cast or the cut gear which is summed up as one of workmanship, not altogether favourable to the cut gear, which is often as bad as the worst cast gear, and never better than the best.

The author is not carried away by any bias; he has an open mind on all questions, and draws his conclusions with judicial impartiality. The printing and illustration is well done, save only the fearsome illustration on page 139.

The Compound Engine. By F. R. Low. New York: The Power Publishing Company. 1900.

We have received this small book, which has been reprinted from the columns of our contemporary, *Power*. The author has endeavoured to give a plain and simple explanation of the action of the compound engine, and has fairly succeeded in his aim. He shows first the general effect of expansion in securing economy, and points out how an early limit is placed to expansion by the action of the cylinder surfaces, because the ratio of steam condensed is increased by early cut-off, when, of course, there is less steam admitted, and the portion destroyed by the cylinder metal must necessarily be greater.

He deals next with the cut-off in the larger cylinder, which he would fix so as to prevent drop between the cylinders, a proceeding as to which there is something to be said on the other side by those who prefer some drop, or, at least, are quite opposed to any such early low pressure cut-off as shall compel the high pressure cylinder to do much in the way of compressing the exhaust steam into the receiver. He then deals with the number of expansions possible, and

points out that expansion has an early limit of profitable extension, so that for single cylinders and initial pressures of 25 to 30 lbs., the expansion cannot be made above 2½ to 3 fold; for compound engines, and 60 to 100 lbs. pressure, the rate of expansion may be 6¼ to 9 times. Triple engines, with steam of 120 to 300 lbs., may have 16 to 27 expansions, while quadruple expansion may extend to 40 or 81 fold, with a steam pressure of 350 to 800 lbs.—this latter evidently prospective. There is so little to be gained by passing from 16 to, say, 20 expansions that the increase may easily be thrown away by other conditions, and all this high ratio work demands particular attention to grasp the somewhat elusive economy that is doubtless there under proper conditions. The combination of diagrams is next dealt with, and finally the question of receiver volume, which the author would settle in his way by making the receiver as large as possible, bearing in mind that beyond a certain size it begins to lose more by radiation than it gains from its increased volume. Receivers simply equalise pressure between the two cylinders, serving as a chamber into which one cylinder exhausts, and from which the other cylinder draws. The receiver enables the low pressure cut-off to be varied over a wider range if necessary, than is possible when no receiver is present, but otherwise it is not an unmixed blessing. Altogether this pamphlet is a readable production.

TELEGRAPH AND TELEPHONE NOTES.

(*Continued from page* 1011.)

The Pacific Cable.—The *Morning Post* on 8th inst. said:—"An agreement has been arrived at between New South Wales and the Colonial Office with regard to the Pacific cable problem, and to judge from Mr. Lee's reply to Mr. Chamberlain's message, no further opposition need be anticipated from the Mother Colony. Virtually now the matter is settled, and the new century will see the laying of the much-talked-of all-British cable between Vancouver and Sydney *vid* New Zealand. Presumably, therefore, Sir Sandford Fleming's proposals as to the Cape-Australia cable have also been accepted by New South Wales, and United Australia will soon have the benefit of two additional telegraphic links."

In the course of a recent address to the Melbourne Chamber of Commerce, the Hon. Robert Reid made reference to the Pacific cable scheme as follows:—"The great idea of a State-owned cable round the world, landing only upon British soil, must never again be abandoned. If the Eastern Extension Company will construct it at once, so much the better; but it can only be sanctioned upon the express condition that the Imperial and Colonial Governments interested should have the right of purchasing it, after reasonable notice, at a fair valuation, the basis of which could be fixed now. Much has been written concerning the early acceptance of the Eastern Extension Company's offer by South Australia (£18,810), West Australia (£8,670), and Tasmania (£9,340), but their share of the guarantee, if called upon to pay, is not one-sixth of the total, being only £36,820 for the three colonies out of a total of £227,000, and the landlines of South and West Australia are dependent for revenue upon the Eastern Extension Company."

Sydney Telephones.—A Telephone Inquiry Board has been sitting at Sydney (N.S.W.). At the end of April it proceeded with the examination of witnesses, Mr. P. B. Walker (Chief Electrician and Engineer-in-Chief of Telegraphs), Mr. J. Watson (Manager of Telephones), and others, being examined. The Board then paid a visit to the basement cable room and the telephone tunnels, accompanied by Mr. Walker, who pointed out the extensive provision which had been made for future requirements of the telephone system. The Board was to visit some of the principal suburban telephone exchanges.

The Board was appointed by the Postmaster-General in view of the complaints made regarding the working of the telephone system. It consisted of three electrical experts—namely, Mr. T. Howard (electrical engineer in the Victorian Postal Department), Mr. Lee Murray, of Messrs. Siemens Bros., and Mr. J. R. Bainton, of Messrs. Edge & Edge—who will report upon the present trouble, ascertaining the cause, and whether the delays and other irregularities are unavoidable.

Uganda Telegraphs.—A notice signed "F. Rawson, for Chief Engineer, Uganda Railway," was issued at Zanzibar, in April, stating that the telegraph line is now open to Kampala and messages will be received for the following stations at the usual rates:—

Naivasha,	Karanias (Usoga),
M'baruk (Lake Elementeita),	Iganga (18 miles from Ludwa),
Eldoma Ravine,	Jinga Ferry (Nile),
Molo,	Kampala (Uganda)
Fort Ternan (Mau Escarpment)	Port Alice (Entabbe),
Mumias,	Port Florence.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
West Indies:—		
Jamaica-Colon	June 30, 1899 ...	...
Trinidad-Demerara (1871) ...	May 11, 1900. ...	...
Mole St. Nicholas-Cape Haitien...	March 6, 1900 ...	...
Cayenne-Pinheiro	Oct. 11, 1899 ...	...
Cayenne-Paramaribo	Feb. 16, 1900 ...	...
Pará-Maranham	March 1, 1900 ...	...
Ceará-Maranham	Feb. 20, 1900 ...	...
Latakia-Cyprus	June 20, 1899 ...	...
St. Thomé Loanda	May 20, 1900 ...	June 11, 1900
Tarifa-Tangier	Jan. 2, 1900 ...	...
Landlines.		
South African:—		
Communication with Mafeking and beyond	Oct. 13, 1899 ...	...
Communication beyond Newcastle	Nov. 7, 1899 ...	...
Communication with all offices beyond Kimberley	Oct. 18, 1899 ...	...
Communication with all offices of Colombia beyond Buenaventura...	Feb. 22, 1900 ...	...
Communication "*vid* Hanakine" interrupted on Persian Territory	Feb. 24, 1900 ...	...
Ecuador landlines	Mch. 13, 1897 ...	...
Brazilian landlines, south of Macahé	Apl. 25, 1900 ...	...
Chinese landlines between Tientsin and Pekin	June 12, 1900 ...	...

The Volta Centenary. — The Brothers Geronimi, of the Organising Committee of the Volta Centenary Fêtes, have been engaged for some eight months in producing an illustrated record or chronicle of the celebrations. The work has been undertaken without any idea of profit, and they have succeeded in issuing for the anniversary of the fêtes a most interesting volume. Full quarto in size, it contains 500 pages of printed matter, and over 300 phototype illustrations. Narratives of the fêtes appear in Italian, French, German, and English. An official report of the congress is included, and the report of the jury on the telegraph competition. Special articles on Volta and Como, his birthplace, are added from the pens of Signor Silvio Dalponti, Director of Telegraphs at Milan, Prof. Gaetano Negri, and Signor Camillo Colombi. The bronze commemoration medal struck for the fêtes is presented to each purchaser, and the book is sold at actual cost price. It forms a very complete and sumptuous record of a most interesting event, and must be of special value to all who are concerned in telegraph work. It can be obtained from the English Volta Sub-Committee, 12, Newgate Street, price 7s. 6d. bound, and 5s. in paper, post free.

CONTRACTS OPEN AND CLOSED.

OPEN.

Bermondsey.—June 18th. The Vestry is inviting tenders for insulated electric mains, conduits, junction boxes, &c. See "Official Notices" June 1st.

Bootle.—June 16th. The Corporation wants tenders for underground electric cables, the erection of arc lamps, and the supply of mechanical stokers, for electric lighting. See "Official Notices" May 25th.

Blackpool.—June 18th. The Corporation wants tenders for the electrical equipment of 15 single truck tramcars. See "Official Notices" June 1st.

Bradford.—June 14th. The Corporation wants tenders for a switchboard for 500 volts pressure, or for alterations to the existing switchboard at the Valley Road electricity works. See "Official Notices" May 25th.

Brussels.—September 19th. The Council of St. Jilles, lez Bruxelles, invites tenders for the installation and the commencement of supply upon a part of its territory. Conditions and plan for three francs at the office, No. 14, Parvis St. Jilles, St. Jilles.

Bury.—June 18th. The Art Gallery Committee want tenders for the electric wiring of the Art Gallery and Free Library. See "Official Notices" June 8th.

Dudley.—June 30th. The Corporation wants tenders for condensers (barometric), pumps, cooling tower, &c., for the electricity works. See "Official Notices" to-day.

Durban.—July 20th. The Corporation wants tenders for overhead equipment for (*a*) about 16 miles of single track, including poles, overhead trolley wire, distribution boxes; (*b*) 22 double-deck motor cars; (*c*) steam and electric generating plant, including three 250-KW. generators, boilers, condensers, cooling towers, switchboard, &c. See "Official Notices" May 18th and this week.

Egypt.—July 1st. Tenders are being invited until July 1st by the harbour and lighthouse authorities at Alexandria for the supply and erection of the necessary plant and apparatus required for the electric lighting of the harbour of Port Said. Tenders are to be sent to L'Administration des Ports et Phares, Alexandria, whence particulars may be obtained.

France.—June 19th. The French Post and Telegraph authorities in Paris are inviting tenders until the 19th inst. for the supply of 300 tons of copper wire. Particulars may be obtained from, and tenders are to be sent to, Le Sous-Secretariat d'Etat des Postes et des Telegraphes, Rue de Grenelle 603, Paris.

Halifax.—The Corporation wants tenders for bar copper for electrical purposes, as well as for boilers and piping. See "Official Notices" June 1st.

Italy. — July 14th. The Municipal authorities of Maddalena (Sardegna), are inviting projects and tenders until July 14th, for the electric lighting of the public streets of the town. Particulars may be obtained from, and schemes and tenders are to be sent to, Il Municipio di Maddalena (Sardegna.)

Larne.—June 18th. The Urban District Council invite tenders for the lighting of their district by coal or acetylene gas or electricity, for three years, from August 1st next. Particulars from Mr. W. G. Younge, Clerk of the Council.

London County Council.—June 16th. The Council invites tenders for an electric lighting and power installation (excluding generating plant) telephones, fire alarms, &c., at the Horton Asylum, near Epsom. See "Official Notices" May 18th.

London.—June 21st. The Guardians of the St. Saviour's Union want tenders for the erection of electric fire alarms, generating station at South End. They will also supply similar work at the Chester electricity works.

Bristol.—The City Council has given a contract to Messrs. Ferranti for an exciter switchboard at £385 10s., in connection with the electricity works extensions.

Dundee.—The Police Commissioner has decided to accept the offer of Messrs. Lucy & Co. for arc lamps and posts, their offer being the lowest. Mr. Hawtayne's original estimate was for 30 pillars and lamps at a cost of £1,600. Since then it had been agreed to erect 64 pillars and lamps at a cost of £2,141.

Edmonton.—The Board of Guardians has accepted, subject to the approval of the Local Government Board, the tender of Messrs. Preece & Co. for the supply of additional electric light machinery, at a cost of £1,600.

Leyton.—The District Council is ordering feeder cables from the Western Electric Company and the British Insulated Wire Company.

London.—Tenders were recently invited for the wiring of the new palace of Cardinal Vaughan, Catholic Archbishop of Westminster. It is proposed shortly to light the cathedral but this is not included in the following list of tenders. That of Messrs. W. J. Fryer & Co. was accepted. Messrs. O'Gorman and Cosens-Hardy are consulting engineers:—

Catholic Archbishop's Residence, Westminster, S.W.—Section A, house wiring; Section B, bells; Section C, lamps.

Name.	Section A.	Section B.	Section C.	Reduction.	Lump sum for A. B. & C. if placed together.	Schedule prices.			Remarks.
						Flex.	Elec. pt.	Bell pt.	
Tamplin & Makovski	£2,053 5 9	£293 2 9	..	*nil*	..	3/-	55/-	45/-	Cannot quote for lamps.
Eastlakes, Limited..	1,236 0 0	101 0 0	1/9 & 2/3	"	£1,487 0 0	..	£2 17 6	£1 4 0	
Middleton & Co.	910 10 0	166 9 0	£56 15 0	"	1,140 6 0	2/10	29/-	31/3	Not to specification.
Tyler & Duncan	958 16 0	99 19 0	56 15 0	"	1,108 10 0	2/2	22/-	15/-	
Slater & Co.	915 0 0	120 15 0	54 10 6	"	1,090 5 6	3/-	58/6	36/-	
Drake & Gorham	878 0 0	138 15 0	64 5 0	£80 0 0	1,051 0 0	3/-	35/-	27/6	
Glover & Co.	609 10 0	99 15 0	1/7 & 1/5	..	966 0 0	1/6	£1 17 0	17/6	
F. Hodgson & Co.	686 16 0	65 0 0	£64 0 0	2½% = £20/7/6	795 8 6	1/6	34/6	20/-	
Donnison, Berlyn, Sillem & Co...	580 5 0	98 10 0	60 0 0	50 0 0	688 15 0	..	30/-	22/6	
A. H. Wood	587 0 0	74 0 0	65 0 0	80 0 0	645 0 0	2/6	30/-	25/-	
W. J. Fryer & Co., Limited ..	538 0 0	49 0 0	54 0 0	19 0 0	610 4 0	1/10	28/-	16/-	

the supply and erection of telephones, &c., and the laying of fire mains, and other work at the Infirmary, East Dulwich Grove. See "Official Notices" this week.

London.—July 10th. The London County Council is prepared to receive tenders for the supply, within three months of the order being given, of about 70 arc lamp standards, required in connection with the electric light installation for the Victoria Embankment. Specification, form of tender, and other particulars at the engineer's department, County Hall, Spring Gardens, S.W., upon payment of the sum of £1.

Limerick.—July 4th. The Council wants tenders for cables, arc lamps, engines, dynamos, booster, balancer, switchboard, instruments and gas plant, for electric lighting. See "Official Notices" to-day.

Manchester.—June 30th. The Tramways Committee wants tenders for the overhead equipment of three routes of tramways. See "Official Notices" to-day.

Newington.—June 15th. The Electric Lighting Committee requires tenders for supplying and laying conduits, mains, &c. See "Official Notices" June 1st.

Servia.—June 21st. The Post and Telegraph authorities in Belgrade are inviting tenders until the 21st inst. for the supply of 30 tons of silicium-bronze wire 3 mm. diameter, 35 tons of iron wire 4 mm. diameter, and 27,000 porcelain insulators. Particulars may be obtained from, and tenders are to be sent to, Die Post und Telegraphen Abtheilung im Bantenministerium, Belgrade, Servia.

Spain—June 22nd. Tenders are being invited until the 22nd inst. by the Spanish post and telegraph authorities in Madrid for the supply of 10,000 zinc cylinders for primary batteries. Tenders to be sent to La Direccion General de Correos y Telegrafos, Madrid, whence particulars may be obtained.

Spain.—July 7th. The Secretary of State for Foreign Affairs has received a despatch from Her Majesty's Ambassador at Madrid, stating that tenders are invited by the Spanish Government, to be received not later than July 7th next, for the concession for an electric tramway from the Puerta de Hierro (Madrid) to Aravaco and Pozuelo. Some particulars may be examined on personal application at the Commercial Department of the Foreign Office between 11 a.m. and 5 p.m.

Sutton Coldfield.—June 21st. The Corporation invites tenders for water-tube boilers and other steam plant, pipework, three steam dynamos and boosters; batteries, switchboard, overhead traveller, mains and conduits, arc lamps and posts, and station lighting. See "Official Notices" May 18th.

CLOSED.

Birkenhead.—The Babcock & Wilcox Company are to carry out the steam and other piping work for the Corporation

FORTHCOMING EVENTS.

Wednesday, June 20th.—Convention of the Municipal Electrical Association opens at Huddersfield.

Friday, June 22nd.—At 5 p.m. Physical Society. "Notes on Gas Thermometry," by Dr. P. Chappuis; "A Comparison of Impure Platinum Thermometers," by Mr. H. M. Tory; "On the Law of Cailletet and Mathias and the Critical Density," by Prof. J. Young, F.R.S.

Saturday, June 23rd to July 4th.—Tramway and Light Railways Exhibition at the Agricultural Hall, London.

Tuesday, June 26th.—Institution of Electrical Engineers' conversazione. Reception by Prof. Perry and Mrs. Perry.

NOTES.

The Municipal Electrical Association.—Next Wednesday this Association opens its four days' convention at Huddersfield, under the presidency of Mr. A. B. Mountain, the Huddersfield Council's electrical engineer. The topics which are covered more or less briefly in the papers by way of introducing discussion, all point to a good meeting if only the right men are there to express their views upon them. We anticipate a successful meeting of borough electrical engineers and their committee men, but, as was the case last year, the meeting will be open to any and all electrical men who take an interest in municipal electrical works, whether as officials or as manufacturers and contractors. This feature is an excellent one, and compares very favourably with what was done in the earlier days, when one imagined that the roll of the Association was more or less closed to those who were not municipal officials or committee men. It does not need any additional emphasis from us to show that it is well for all if the manufacturer can meet with his clients for the consideration of matters of moment, and come into touch with him in such a way as is possible by the medium of the Municipal Electrical Conventions.

A Yiddish Edition.—It has been stated that the maximum demand system is not always plain as a pike staff to the English householder who has a pamphlet placed before him explaining its advantages in common English language. There is sometimes a suspicion that it is a sly attempt to "do" the public, a sort of wolf in sheep's clothing affair. We can, therefore, well understand the confusion of the Semitic colonists of Whitechapel when Mr. Arthur Wright and Mr. Tapper endeavour to explain the methods of charging adopted there. Not knowing how to read a word of English, the very large Jewish population upon whom the Whitechapel electricity works will depend for a great deal of their business are dumb-founded. Therefore, the electricity officials have risen to the occasion *pro bono publico*, primarily, of course, for the success of the electricity works, and, perhaps, to escape a charge of being anti-semitic. They have issued an edition of their usual pamphlet in Yiddish, and to us it is quite beyond criticism. We wish every success to

ארטהור ווריט,

ראמהגלעבענדער אינזשינער אונד מענעדושער,

וו. צ. פ. מאפפער,

אינזשינער אם פלאץ אונד מענערושער.

and hope that their pamphlet will run through *many editions!*

The English Electric Manufacturing Company, Limited.—On Wednesday the directors of the English Electric Manufacturing Company, Limited, invited the representatives of the Electrical Press, and other gentlemen interested in electric traction, to inspect their works at Preston, and also to dinner at the Park Hotel. We have already alluded at some length to the proposed operations of this company in our issue of December 8th, 1899, and we hope next week, and possibly in succeeding issues, to describe and illustrate their works, as they now exist, in a manner worthy of the nature of the undertaking. The works were formally opened yesterday (Thursday) in the presence of a large and distinguished gathering of visitors, including the Lord Provost of Edinburgh, Prof. Silvanus P. Thompson, Mr. Clarke, the managing director of the foreign department of the General Electric Company, of America, Mr. Rice, vice-president of the same company, Mr. Linder, managing director of the French Walker Company, and many well-known engineers and tramway magnates. The engines, made by Messrs. Musgrave, were started by Mrs. Prestwich, wife of the chairman of the English Electric Manufacturing Company, amidst great cheering. The success of the new works is assured.

Ching Chang Chinaman!—A good deal of interest attaches to electrical affairs in the East just now; therefore it is worth quoting from the *Hong Kong Daily Press* that the Canton Electric Lighting and Fire Extinguishing Company, Limited, has just held an extraordinary general meeting. Among those present were Mr. Fung Wa Chuon, who presided, and Messrs. Lil Tze San, Tam Tsz Kong, Li Yuk Tong, Lo Ki, Tam Wai Tong, Chan He Wan, Liao Fung Shu, Fung Hi, Lam Yuk Ling, and Pun Tsz Seung. The chairman, Mr. Fung Wa Chuon, proposed that the company be wound up voluntarily. Mr. Tam Tsz Kong seconded, and the motion was carried unanimously. On the motion of the chairman, seconded by Mr. Lil Tze San, Mr. Li Yuk Tong was appointed liquidator. In the absence of a reason for this liquidation, we are left to our own imaginings to ascribe a cause!

Chair of Physics.—Convocation at Oxford on 12th inst. passed a statute providing that the subjects on which the occupant of the newly-established Wykeham Chair of Physics, for which the endowment, in accordance with the arrangements of the University Commission, is provided by New College, shall chiefly lecture, shall be electricity and magnetism. The election of a professor will be proceeded with as soon as possible.

Municipal Insurance.—At the Shoreditch Town Hall the other day nearly 100 delegates appointed by metropolitan central and local authorities attended a Conference to consider the question of municipal mutual insurance. Mr. Joseph Cox (Shoreditch Vestry) presided. Dr. Robinson, clerk to the Shoreditch Vestry, acted as secretary, and presented returns of fire and other insurances effected by metropolitan central and local authorities. The latest returns showed the total amount insured against fire to be £11,002,855, the annual premiums £14,456, and the losses in five years £11,705. We read in the *Times* that the following resolutions were passed:—

That having regard to the large and increasing amounts now paid by central and local authorities in London in insuring municipal property, and the small sums received in respect of losses, this Conference is of opinion that it is desirable that a system of mutual municipal insurance should be adopted, in order to secure for the ratepayers the benefits of this class of business.

That a representative committee be appointed from the delegates present to formulate a scheme for the establishment of a system of mutual municipal insurance for London central and local authorities, and that the same be submitted at a subsequent meeting of the Conference.

Lightning.—Lightning has done a good deal of evil work during the past few days. The reports of the thunderstorms of Monday and Tuesday show that a number of people have been struck dead, many buildings have been wrecked and others burned, and altogether the chapter of accidents is more serious than has happened for some time. Among the fatalities was the death of Major and Hon. Lieut.-Col. R. H. Jones, on Monday, at the Yeomanry Brigade Camp at Harrogate. One account suggests that the umbrella he carried at the time attracted the lightning. His chest and the upper part of his throat was slightly blackened, but reports are conflicting as to whether the umbrella or his clothes were harmed. On Tuesday morning three children were killed by lightning while leaving school at Arthingworth.

In connection with this subject we may mention that a paragraph is now going around among certain halfpenny daily papers that

the Electrical Review states that "the lightning rod, no matter what pattern, or whose invention; no matter what it cost or what the limber-jawed dealer said of it, has no more influence over the course of the lightning than the colour of the paint on our houses."

As we have been asked if we ever said this, we think it as well to remark that the statement has never appeared in our columns. We rather think that it is extracted from a much longer article in the New York *Electrical Review*, and we may mention that it is not always possible to convey an accurate impression of an article on a subject such as this without the context being given. Furthermore, we prefer not to accept responsibility for the recent remarks of our New York contemporary on this subject.

From a note in the *Daily Mail*, it appears that when the premises of a Coventry watchmaker were struck by lightning the other day, all of his tools and stock of watches in the workshop on the top floor were magnetised, some of the larger tools being completely spoiled.

Appointments Vacant.—The directors of the London Exhibitions, Limited, want a chief electrical engineer at Earl's Court. See "Official Notices" to-day.

An assistant superintendent is wanted for the Indian Telegraph Department at Rs3,600 per annum; age below 24 years. See "Official Notices" to-day.

A "chief generating assistant" is wanted for the Poplar electricity works at £156 per annum. See "Official Notices" to-day.

The Stafford Corporation is wanting an engineer and manager to take entire charge of the gas and electricity works at £350 per annum. Applications to be sent to the Town Clerk by Saturday, 16th inst.

The Urban District Council of Leyton wants a shift engineer for the electricity department at £100 to £150 per annum. See "Official Notices" to-day.

The Dublin Lighting Scheme.—The hon. sec. of the Irish Section of the Institution of Electrical Engineers advised us that Mr. Robert Hammond was to deliver his address on the proposed Dublin electric light and power scheme at the Royal Dublin Society (Council Room) yesterday, Thursday, 14th inst.

carry out the steam and other piping work for the Corporation

trical Conventions.

Obituary.—We regret to learn, from the *Times* of Wednesday, of the death of Dr. Julius Althaus, whose name will be familiar to most of our readers in connection with his work in electro-medical science. We understand that previous to 1860 he had been assisting Dr. Todd in the electrical treatment of patients at King's College Hospital. In 1866 he founded the Regent's Park Hospital for Epilepsy and Paralysis, with which he has been associated ever since, latterly as consulting physician. Among his literary works connected with his profession was one on "Medical Electricity." The *Times* says that he was the acknowledged authority in England on the use of electricity in medical practice. He was 67 years of age.

"Working Destructions."—A correspondent draws our attention to the directions which accompany a certain medical battery, made in Germany. The directions were evidently made there too—for example:—

Now, if put in the zinc-staff, you must be careful that the zinc does not come deeper in the acid as it is necessary, because the acid will get then very quick bad, without increasing the effect of the apparatus.

When the acid was used some time it will get dark; this shows that it is no more strong enough to drive the apparatus well, the reforce take out the acid and clean the glass with water, afterwards fill up new acid, and the apparatus will go on again very well.

Society of Engineers.—Mr. A. H. Binyon brought the subject of "Electric Traction" under the notice of members of this Society on Monday last. Mr. Binyon went into the growing importance of electric traction, giving some comparative statistics of English and American progress. The method and apparatus employed for trolley lines, both in regard to the power station equipments and line construction, were fully described, and the paper was made the more interesting by models and apparatus which were on exhibition.

Change of Address.—The Lancashire Dynamo and Motor Company, Limited, inform us that their future address will be Trafford Park, Manchester, only. All communications should be addressed there.

The Light Railways Exhibition.—The chairman and members of the Tramways Committee of the Liverpool Corporation have resolved to accept an invitation from the Exhibition authorities to be present at the Agricultural Hall Exhibition.

An Austrian Electrical Exhibition.—The Electrotechnische Verein of Vienna has decided to organise a large electrical exhibition, to be held in Vienna from May to October, 1903, to celebrate its twentieth year of existence. The large building known as the Rotunda of the park connected therewith has already been secured as the *locale* of the exhibition.

Fatality.—A night watchman and switchboard attendant (age 17) was found dead at the Deptford station of the London Electric Supply Corporation last Saturday morning. There is at present considerable mystery about the affair, and there is uncertainty as to whether death was due to asphyxia or electric shock. The inquest was opened on Monday and adjourned.

Paris Electric Railways.—The Paris Metropolitan Electric Railway inaugurated its first branch line from Vincennes to the Bastille on Friday last week.

Research Fellowship.—From an "Official Notice" in this issue it will be seen that a research fellowship in pure or applied physics (£100) is offered by Owen's College, Manchester. Preference will be given to the subject of electrochemistry or electro-technics.

Correction.—In Mr. V. Zingler's letter on "The Protection of Insulated Wire," printed in last week's issue, in the fourth line on p. 965, for "under so far," read "under sofas."

The Metropolitan Electric Railway.—The experimental electrical railway at Earl's Court was visited by a party of members of the Institution of Junior Engineers on Saturday last, June 9th.

Earl's Shipbuilding and Engineering Company, Limited.—We learn that the directors have called a meeting of the company for Thursday next, with a view to voluntary winding up. They "trust," however, that it may be reconstructed.

NEW COMPANIES REGISTERED.

Scottish Electrical Lumscriptor Company, Limited (4,555).—This company was registered in Edinburgh on May 30th, with a capital of £10,000 in £1 shares, to purchase the exclusive right throughout Scotland only to sell, work, exhibit, grant licenses in respect of, or otherwise use the invention of Walter Claypoole for improvements in, or connected with, apparatus for optical projection for advertising and other purposes (Patent No. 2,044), and to carry on the business of engineers, fitters, and millwrights. The first subscribers (each with one share) are:—William Bow, 61 to 71, High Street, Glasgow, warehouseman; Henry Wardlaw, Honor Oak Park, London, Bart.; R. Peacock, Pollockshields, Glasgow, confectioner; Edward Scott, 39, Jamaica Street, Glasgow, boot manufacturer; J. A. Mitchell, 59, St. Vincent Street, Glasgow, chartered accountant; William Pollock, 59, Cadder Street, Pollockshields, clerk; and George Parker, 180, Hope Street, Glasgow, solicitor. The number of directors is not to be less than three nor more than seven; the first are Sir Henry Wardlaw, William Bow, R. Peacock, and Edward Scott; qualification, 100 shares; remuneration, £100 per annum each (£150 per annum for the chairman). Registered office, 180, Hope Street, Glasgow.

H. & H. Accumulator, Limited (66,112).—This company was registered on May 31st, with a capital of £10,000 in £1 shares, to adopt an agreement with Charles Bright & Co., Limited, and to manufacture and deal in storage and other batteries, motors, locomotives and all kinds of fittings, apparatus and appliances connected with the generation or use of electricity. The first subscribers are:—P. G. Judge, 38, Beecroft Road, Brockley, secretary, 3 shares; J. F. Moreno, 20, Dalrymple Road, Brockley, gentleman, 2 shares; A. F. Abel, 37, Sydner Road, N., clerk, 1 share; S. C. Lewis, 26, Vicarage Road, Tottenham, secretary, 1 share; T. G. Chance, 129, Hopton Road, Streatham, S.W., gentleman, 2 shares; C. W. Bennett, Prince's House, Palace Street, S.W., gentleman, 2 shares; H. Slack, 9, Lochaber Road, Lee, S.E., secretary, 2 shares; J. Thome, Whippendale, Herts, gentleman, 3 shares; F. J. E. Bankart, 56, Sinclair Road, W., clerk, 2 shares; and A. H. Payn, 55, Almack Road, Lower Clapton, 2 shares. The number of directors is not to be less than two nor more than five. The subscribers are to appoint the first; qualification, £10; remuneration as fixed by the company.

Motor Wheels, Limited (66,092).—This company was registered on May 30th, with a capital of £100 in £1 shares, to manufacture and deal in steam, oil, electrical and other motors, motor carriages and vehicles, bicycles, velocipedes, tyres, india-rubber goods, cycle and motor accessories, &c. The first subscribers (each with one share) are:—H. C. Thomas, 36, Greenwood Road, Hackney, manufacturer; A. C. Pendry, 40, Holborn Viaduct, E.C., clerk; T. T. Bradbury, 40, Holborn Viaduct, E.C., secretary; J. Likeman, 40, Holborn Viaduct, E.C., salesman; J. A. Gladwin, 40, Holborn Viaduct, E.C., gentleman; C. Osborne Rensbury, Kingsfield, Watford, secretary; and J. T. Smith, 5, Denbigh Street, S.W., engineer. Registered without articles of association.

Brianne Electric Lamp Company, Limited (66,139).—This company was registered on June 6th, with a capital of £30,000 in £1 shares, to adopt an agreement with M. Hill, and to carry on the business of manufacturers of patent electric and other lamps, and their appliances, accessories and apparatus. The first subscribers (each with one share) are:—W. Townsend, 51, Wellington Road, N.W., secretary; H. M. Delacour, 2, Albert Street, Victoria Square, S.W., engineer; Ella Dawson, Brunswick House, Brunswick Square, W.C., secretary; W. W. Ellwood, 4A, Surrey Road, Newlands, Peckham, S.E., clerk; H. Clegg, 56, Hemingford Road, N., clerk; C. C. Willson, Connemara, Finborough Road, S.W., clerk; and S. Napier, 59, Lydhurst Avenue, Streatham, S.W., accountant. The number of directors is not to be less than three nor more than five. The first are J. B. Whyte, M. Kilner and W. Townsend; qualification, £100; remuneration not less than £100 each per annum.

Gateshead Electric and Mechanical Supply Company, Limited (66,151).—This company was registered on June 6th, with a capital of £1,000 in £1 shares, to adopt an agreement with J. A. M. Collier, W. Brown, and J. Mennie, for the acquisition of the business carried on by J. A. M. Collier, at 25A, and 57, West Street, Gateshead, hotel manager; S. A. Brown, 24, Granville Street, Gateshead; assistant manager; J. A. M. Collier, Claremont Grove, Claremont Place, Gateshead, electrical engineer; T. Romanis, 3, Hardwicke Terrace, Gateshead, painter; J. B. Mennie, 27, Warrington Road, Newcastle-on-Tyne, watchmaker; R. C. Twibell, 100, Prince Consort Road, Gateshead, hotel manager; and William Brown, 61, Claremont South Avenue, Gateshead, blacksmith. The number of directors is not to be less than three nor more than five. The first are John B. Mennie, Thomas Romanis, and James A. M. Collier (managing director, with £130 per annum).

CITY NOTES.

The British Electric Traction Company, Limited.

The directors' report to be presented to the shareholders at the fourth ordinary general meeting to be held at Donington House, Norfolk Street, Strand, W.C., on Monday, June 18th, reads as follows:—

"The directors beg to submit their report and statements of accounts for the 15 months ended March 31st, 1900.

"*Profit and Loss Account.*—The profits, including £35,451 13s. 8d. brought forward from last year (but without taking into account the premiums, £160,529 15s. 3d., received in respect of new share and debenture capital), amount to £159,122 15s., and after deducting the proportion of general expenses chargeable to revenue, and also the expenses incurred in connection with schemes not proceeded with and written off, and interest on debenture stock, there remains a net profit of £130,174 16s. 2d., which the directors propose should be applied as follows:—

Reduction of goodwill account	£5,000	0 0
Addition to reserve	20,000	0 0
Reduction of furniture account	469	1 9
Dividend at the rate of 6 per cent. per annum, on preference shares for the 15 months ended March 31st, 1900, on account of which interim dividends have been paid to February 15th, 1900	23,051	18 9
Dividend at the rate of 8 per cent. per annum on the ordinary shares for the 15 months ended March 31st, 1900, on account of which an interim dividend at the rate of 6 per cent. per annum, has been paid for the nine months ended September 30th, 1899, leaving a balance dividend payable of 11s. per share, Nos. 1—80,000, and 8s. 7½d. per share, Nos. 66,001—75,000 ..	87,869	16 10
Carried forward to next account	43,783	18 10
	£130,174	16 2

"*Capital Account.*—Since December 31st, 1898, the directors have issued 40,000 6 per cent. cumulative preference shares of £10 each at £12 per share, and 15,000 ordinary shares of £10 each have been allotted to the shareholders at £15 per share. There has also been issued £250,000 5 per cent. perpetual debenture stock at an average price of £120½ per cent. The total premiums received in respect of these issues, after deducting the expenses, amount to £160,529 15s. 3d., and the whole of this amount has been added to reserve. The subscribed share and debenture capital is now:—

£450,000 in ordinary shares of £10 each;
500,000 in 6 per cent. cumulative preference shares of £10 each;
350,000 5 per cent. perpetual debenture stock.

£1,300,000

Of the authorised share capital there is at present unissued 15,000 ordinary shares of £10 each and 10,000 preference shares of £10 each, which the directors propose at an early date to allot to the shareholders on terms to be announced. The whole of the present authorised share capital of the company will then be issued, and the directors recommend that powers be taken to increase the nominal capital of the company by the creation of 80,000 shares of £10 each: and notice is given herewith of an extraordinary general meeting of the shareholders to consider, and, if deemed advisable, to pass, the necessary resolution.

"*Contracts and Undertakings*—The total amount expended under this head, after deducting the costs of undertakings transferred, and after writing off expenses incurred in respect of schemes not proceeded with, but including a proportion of general expenses, is £543,246 12s. 4d., made up as follows:—

Expenditure and profit on works and undertakings for account of other companies	£277,148	19
Expenditure on works and undertakings owned, leased or controlled by the B.E.T. Company, and for general stores	234,019	15 8
Expenditure on negotiations, &c., in connection with new schemes in course of development, and on Acts of Parliament, provisional orders, light railway orders, and other rights and powers in course of promotion ..	32,077	17 5
	£543,246	12 4

"*Investments.*—The total expenditure under this head, after deducting cost of securities sold or written off, is £950,280 0s. 1d., and is made up as follows:—

Consols (cost)	£61,296	2 8
National War Loan (£6,000) .. .. .. (paid up)	510	0 0
Parliamentary and other deposits in cash and Consols (cost)	31,658	11 6
Loans and advances to associated companies and others ..	60,023	7 9
Mortgages and debenture stocks of associated and other companies (cost)	75,611	17 10
Shares of associated and other companies (including £24,940 in the B.E.T. (Pioneer) Company, Limited (cost)	721,180	0 4
	£950,280	0 1

N.B.—There are certain contingent liabilities in respect of some of these investments.

"*Superannuation Fund.*—The directors have had under consideration the desire expressed by officers of the company and of the associated companies that a superannuation fund should be established, and a proposal will be made to the meeting that a sum of £25 should be subscribed by the company in respect of each official now in the employ of the company who elects to become a subscriber to the fund, and that the company should make certain annual contributions to the fund.

"*Directors and Auditor.*—Mr. Charles S. Drummond has been appointed a director of the company. The directors who retire this year are Sir Charles Rivers Wilson, G.C.M.G., C.B., and the Hon. Sir Charles W. Fremantle, K.C.B., and both are eligible for re-election. Mr. Fred. W. Smith, F.C.A., retires, and his firm, Messrs. Fred. W. Smith & Co., offer themselves for election."

A very lengthy appendix is circulated with the report, giving particulars of the company's contracts and undertakings in different parts of the country.

An extraordinary general meeting will be held upon the conclusion of the ordinary meeting, for the purpose of passing the following resolutions:—

(1) That the capital of the company be increased from £1,200,000 divided into 120,000 shares of £10 each, to £2,000,000 divided into 200,000 shares of £10 each, by the creation of 80,000 new shares of £10 each, and that the following provisions shall apply to such new capital, namely:—

(a) That 40,000 of the new shares be called preference shares, and 40,000 ordinary shares.

(b) That the new preference shares be entitled to a cumulative preferential dividend at such rate not exceeding 6 per cent. per annum, as the board of directors may, before issue thereof, determine.

(c) That, save as aforesaid, the 80,000 new shares be treated as part of the original capital of the company.

(2) That the proposed Barnsley and District Light Railways (Extensions) Order, a draft of which has been submitted to the meeting, be and the same is hereby approved, subject to all such additions, alterations, and variations as the Light Railway Commissioners or the Board of Trade may think fit to make or sanction therein.

(3) That the proposed Durham and District Light Railways Order, a draft of which has been submitted to the meeting, be and the same is hereby approved, subject to all such additions, alterations and variations as the Light Railway Commissioners or the Board of Trade may think fit to make or sanction therein.

(4) That the proposed Jarrow and South Shields Light Railways Order, a draft of which has been submitted to the meeting, be and the same is hereby approved, subject to all such additions, alterations and variations as the Light Railway Commissioners or the Board of Trade may think fit to make or sanction therein.

(5) That the proposed Kingston, Surbiton and District Light Railways (Extension) Order, a draft of which has been submitted to the meeting, be and the same is hereby approved, subject to all such additions, alterations and variations as the Light Railway Commissioners or the Board of Trade may think fit to make or sanction therein.

(6) That the proposed Sheerness and District Light Railway Order, a draft of which has been submitted to the meeting, be and the same is hereby approved, subject to all such additions, alterations and variations as the Light Railway Commissioners or the Board of Trade may think fit to make or sanction therein.

Isle of Man Tramways Company.

The *Financial Times* Douglas correspondent telegraphing on 6th inst. said that a deadlock had occurred in the proceedings of the committee of investigation into the affairs of the Isle of Man Tramways and Electric Power Company. The directors and the committee met on 25th ult., the day following the shareholders' meeting, when the company's affairs were discussed at length. Eventually it was decided that the directors should interview the trustees for the debenture holders with a view to ascertain their attitude, and, if possible, enlisting their assistance in a scheme which would extricate the company from its difficulties. The committee was not called together again until Tuesday last week. At the opening of the meeting the minute of the resolution of the previous meeting was read, and its accuracy was challenged by the mover and others of the committee of inquiry. The minute recorded that the resolution was to the effect that the time had arrived for the debenture holders to be called in, it being considered necessary that they should take action. The minute of the resolution was amended to meet the views of the proposer. A long discussion ensued as to the course to be recommended to the shareholders throughout which the course advocated by the directors was opposed by several members of the committee, who finally quitted the meeting without the resolution being adopted.

City and South London Railway Company.

A meeting of this company was held on Tuesday at the offices, at which the Bill seeking for further powers to be conferred upon the Baker Street and Waterloo Railway Company was approved. The Chairman (Mr. C. G. Mott) said that the Bill sought to extend the Baker Street line as far as Paddington at the one end and to the Elephant and Castle at the other. At the latter place the Baker Street line would connect with the line of this company—not physically, as each line would remain separate—but by means of a pathway. This would not only benefit both companies, but would be an enormous advantage to the public.

The Electric and General Investment Company, Limited.—The directors have decided to recommend the payment of the following dividends, &c., for the year ended May 31st, 1900:—*Ordinary Shares.*—A dividend of 5s. per share, of which 2s. per share was paid on account in December last, leaving 3s. per share to be distributed, and a bonus of 4s. per share, making a present distribution of 7s. per share, or a total distribution of 9s. per share for the year. *Founders' Shares*—A dividend for the year ended May 31st, 1900, of £30 per share and a bonus of £40 per share, making a present total distribution of £70 per share for the year. The dividends, if sanctioned by the shareholders, will be paid on June 27th, 1900.

Stock Exchange Notices.—The Stock Exchange Committee has appointed a special settling day as under:—Wednesday, June 27th, Nernst Electric Light, Limited—180,000 vendors' ordinary shares of £1 each, fully paid, Nos. 1 to 180,000; and 25,000 vendors' 7 per cent. non-cumulative preference shares of £1 each,

Saturday last, June 9th.

(managing director, with £130 per annum).

fully paid, Nos. 115,001 to 140,000; and has also ordered the undermentioned securities to be quoted in the Official List:—British Insulated Wire Company, Limited—Further issue of 12,500 6 per cent. cumulative preference shares of £5 each, fully paid, Nos. 27,501 to 40,000.

Prospectuses.—A prospectus of the Scottish "Electrical Lumiscription" Company, Limited (£10,000 in £1 shares), was last week published in the Glasgow papers inviting subscriptions for 6,000 shares. The list closed on 7th inst.

The list closes to-morrow, Friday, in an issue of £150,000 3½ per cent. debenture stock in St. James's and Pall Mall Electric Light Company, Limited, this being capital required under the company's 1899 Act for the purchase of site at Carnaby Street, erections of new buildings, and the provision of additional plant and machinery.

Sussmann Electric Miners' Lamp Company, Limited.—The report for 1899, to be submitted to the meeting to be held in London on 18th inst., states that the balance at debit of profit and loss is £3,827. The directors state it is evident that either further capital must be found, or that the company must suspend operations and go into liquidation, and they believe, in view of the work accomplished, that an issue of debentures to the extent of £5,000, for which they will ask authorisation, is warranted.

Personal.—It is announced that Mr. C. H. Reynolds, C.I.E., late Director-General of Telegraphs to the India Government, has joined the Board of the Consolidated Telephone Construction and Manufacturing Company, Limited, the Anglo-Portuguese Telephone Company, Limited, and the Edison Gower-Bell Telephone Company of Europe, Limited.

Chilian Electric Tramway and Light Company.—The ordinary general meeting will be held at Bishopsgate House, No. 55 and 56, Bishopsgate, E.C., on the 21st inst., at 2.30 p.m. The transfer books will be closed from the 18th to the 23rd inst., inclusive.

Mexico Electric Tramways.—The ordinary general meeting will be held at Winchester House, Old Broad Street, E.C., on the 20th inst. The transfer books will be closed from the 18th to the 23rd inst., inclusive.

Chelsea Electricity Supply Company.—The transfer books of the preference and ordinary shares and debenture stock will be closed from the 13th to the 30th inst. inclusive.

Bank Rate.—The Bank rate was yesterday reduced to 3 per cent.

TRAFFIC RECEIPTS.

Blackpool and Fleetwood Tramroad Company.—The receipts for the week ending June 9th, 1900, were £1,833 18s. 0d.; receipts for corresponding period, 1899, £640 15s. 0d.; aggregate for half-year to date, £7,728 11s. 3d.

The Bristol Tramways and Carriage Company, Limited.—The receipts for the week ending June 8th, 1900, were £4,708 4s. 3d.; corresponding period, 1899, £3,159 10s. 2d.; increase, £1,548 14s. 1d.

The Dover Corporation Tramways.—The receipts for the week ending June 9th, 1900, were £270 4s. 2d.; June 10th, 1899, £182 16s. 5d.; increase, £87 7s. 9d. Total receipts to date, 1900, £3,857 18s. 1½d.; corresponding period, 1899, £3,629 13s. 11d.; increase, £228 5s. 2½d. Miles of track open, 1900, 3; 1899, 3. Car miles run, 1900, 5,020; 1899, 4,152. Number of cars, 1900, 11; 1899, 11.

The Dublin United Tramways Company.—The receipts for the week ending Friday, June 8th, 1900, were as follows:—D. U. T. Co., horse cars £77 3s. 4d.; ditto, electric cars, £4,276 0s. 11d.; D. S. D. Co., electric cars, £1,254 16s. 7d.; total, £5,608 0s. 10d.; corresponding week last year—D. U. T. Co., horse cars, £2,198 18s. 1d.; ditto, electric cars, £1,411 18s. 4d.; D. S. D. Co., electric cars, £1,095 5s. 5d.; total, £4,705 16s. 10d.; increase, £902 4s. 0d. Aggregate to date, £94,581 18s. 3d.; aggregate to date last year, £80,893 2s. 9d.; increase to date, £13,688 15s. 5d. The mileage worked is 40 miles electrically, 2 miles by horses, as against 18 miles electrically, 26 miles by horses, for the corresponding period last year.

The Halifax Corporation Tramways.—The receipts for the week ending June 9th, 1900, were £1,040; week ending June 11th, 1899, £626; increase, £414. Total receipts to date, 1900, £7,122; ditto. 1899, £4,918; increase, £2 204. Number of cars, 1900, 28; 1899, 14. Miles of track open, 1900, 14; 1899, 64.

The Liverpool Overhead Railway Company.—The receipts for the week ending June 10th, 1900, amounted to £1,781; corresponding week last year, £1,469; increase, £312. Total traffics from January 1st to date, £32,790; corresponding period 1899, £31,795; increase, £995. Miles open, 6 57 chains.

The South Staffordshire Tramways Company.—The receipts for the week ending June 8th, 1900, were £1,225 10s. 1d.; June 9th, 1899, £644 14s. 1d. Aggregate receipts for 23 weeks, £15,560 13s. 10d.; last year, £14,528 16s. 2d.

STOCKS AND SHARES.

Wednesday Evening.

Stock Exchange markets have not been very active during the last week. The business which seemed likely to spring up with the end of the war has still to make its appearance. From South Africa the news is not sufficiently encouraging at present to warrant a full return of public confidence to the investment markets, and the Far Eastern horizon is seriously clouded. The quiet hint given by the Bank of England to the various municipal bodies which have been for some time past on the look out for a favourable chance of raising money has been eagerly accepted, and the haste with which some of the Corporations have acted upon the hint by bringing out new loans has checked to a slight extent the ease of the Money Market. So that, although the Bank rate stands at an eminently businesslike level, the investing public is preferring to withhold its money from Stock Exchange markets until the prospect of cheap money becomes more settled.

There is no doubt that the new issue of £150,000 3½ per cent. Debenture stock now being advertised by the St. James's and Pall Mall Company—the coming of which we announced last week—will be fully subscribed for. It is an attractive investment, and considering how bare the supply market is of gilt-edged stocks, the price of issue makes the new emission look very tempting. How few debenture stocks there are, and the rate they return to an investor, can be shown at a glance:—

Company.	Rate of interest.	Price.	Yield.
Brush	4½	112	£4 0 4
Chelsea	4½	110	4 1 3
City of London	5	127	3 18 9
County of London	4½	112	4 0 4
Edmondson's	4½	103	4 7 6
London Electric	4	101	3 19 3
Metropolitan	4½	115	3 17 6
Do.	3½	98	3 11 3

City of Londons are a weak market, partly on account of the competition which is now so near it in the City. The Charing Cross and Strand has now registered its baby at Somerset House, the name given to it being the Charing Cross and City Electric Company, which will have a capital of £300,000 in 60,000 shares of £5 each. Five directors of the bantling are on the board of the parent undertaking.

In connection with this new concern a courteous correspondent gently chides us for having stated on various occasions that the price of the parent company's shares is lower than they probably would be were it not for the "uncertain outlook" ahead. He contends, quite naturally, that as the Charing Cross and Strand Company will work independently of the newcomer, the quotation for its shares cannot be influenced thereby. Our answer is simply this—that we obtain the information given every week in this column by carefully inquiring of the jobbers in the Stock Exchange the reasons for the fluctuations recorded in our price lists. And we have found that the mere uncertainty as to how and when the new company—which everyone knew was to be formed in obedience with Board of Trade requirements—would be launched, was one of the most active factors in the situation, and that it certainly was helping to depress the price of Charing Cross shares. There are dozens of anomalies to be found in every market of the Stock Exchange just as inexplicable as that to which our friendly reader has called our attention.

Westminster new shares are being actively dealt in, and the price is now 5⅜ premium. The demand made by Somerset House that all the renunciation letters shall be filled up with the full names of the purchaser is being tacitly ignored, as it well deserved to be.

Excellent reading is provided by the British Electric Traction report issued the other day. The dividend is to be made up to 8 per cent. for the 15 months ending March 31st, 1900, the reserve fund stands at £209,000, and the company has interest in no less than 57 electric traction enterprises. The ordinary shares at the present price yield a purchaser 5 per cent. on the money invested, but in our opinion, the Preference are likely to advance in price sooner than the Ordinary. Paying 4½ per cent. to the buyer, there is every likelihood that the price will rise to 16, as it did a year ago.

A Scotch company has lately been registered under the ambitious title of the British Electric Plant Company, Limited. It has a capital of £100,000, and its objects are those of electrical and general engineers. So far we have been unable to discover any Stock Exchange firm which has been approached with the business.

The telegraph market is inclined to be what brokers call "droopy." Anglo-American issues are out of all favour, but there is still a weak bull account existent in Anglo-American. With the American railway market depressed by reports of crop troubles and Berlin failures, it can hardly be expected that the American telegraph companies will do much more than maintain their last year's figures. The Eastern securities are hard, but no business is doing in them. There have been small sales of Western Telegraph shares, and the dealers are extremely disinclined to bid anything over the bottom price for them.

The ill-fated Sussman Electric Miners' Lamp Company reports that its balance to the bad is now £3,827, and the directors say that either fresh capital must be raised or the company must go into liquidation. There has been no market for the shares for months, and to us it seems that the liquidation course would be the better one for the shareholders to adopt.

appointed a director of the company. The directors who retire this

vendors' 7 per cent. non-cumulative preference shares of £1 each,

SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. †	Dividends for the last three years. 1897.	1898.	1899.	Closing Quotation, June 6th.	Closing Quotation, June 13th.	Business done during week ended June 13th. 1900. Highest.	Lowest.
110,900	African Direct Telegraph, 4 % Debs.	100	...	...	...	100 —104	100 —104	...	...
125,000	Amazon Telegraph 5 % Debs., Nos. 1 to 1,250 Red. ...	100	...	...	...	85 — 90	85 — 90	...	...
875,520	Anglo-American Telegraph	Stock	3 %	£3 9s	73/6	62 — 65	61 — 64	...	...
3,062,240	Do. do. 6 % Pref.	Stock	6 %	6 %	6 %	114½—115½	114 —115	115½	114½
3,062,240	Do. do. Deferred...	Stock	...	18s. %	£1 7s	13½— 14	13 — 13½	13⅞	13⅛
44,000	Chili Telephone, Nos. 1 to 44,000	5	4 %	3 %	...	2½— 3½	2½— 3½	...	...
10,000,000$	Commercial Cable	$100	8 %	8 %	...	165 —175	165 —175	...	...
1,563,078£	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	...	...	...	102 —104	102 —104	102⅜	...
16,000	Cuba Telegraph	10	7 %	8 %	7 %	7 — 8	6½— 7½	7	...
6,000	Do. 10 % Pref.	10	10 %	10 %	...	16 — 17	15½— 16½	16⅜	16½
12,931	Direct Spanish Telegraph	5	4 %	4 %	...	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	...	...	9 — 10	9 — 10	...	...
80,000	Do. do. 4½ % Debs.	50	...	...	...	101—105%	101 —105%	...	...
60,710£	Direct United States Cable	20	3½%	3½%	3 %	11½— 12	11½— 12	11⅝	11½
120,000	Direct West India Cable, 4½ % Reg. Deb.	100	...	...	...	100 —108	100 —108	...	...
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	...	150 —155	150 —155	152	150
1,795,000	Do. 3½% Pref. Stock	100	...	...	...	97 —100	97 —100	98	...
1,432,268£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	...	...	111 —116	111 —116	111½	...
250,000	Eastern Extension, Australasia, and China Telegraph ...	10	7 %	7 %	7 %	14½— 14⅝	14½— 14⅝	15¼	14⅝
6,700£	Do. 5 % (Aus. Gov. Sub.) Deb., 1900, red. ann. drgs., reg. 1—1,049, 3,976—4,326	100	5 %	...	...	100 —103	100 —103	...	...
26,600£	Do. do. Bearer, 1,050—3,975, 4,327—6,400	100	5 %	...	...	100 —103	100 —103	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	...	...	112 —117	112 —117	...	...
300,000£	Eastern and South African Telegraph, 4 % Mort. Deb., Nos. 1 to 3,000, red. 1909	100	...	...	...	100 —103	100 —103	...	...
200,000£	Do. 4% Reg. Mt. Debs. (Mauritius Sub.) 1—3,000	25	...	...	...	100 —103%	100 —103%	...	...
180,227	Globe Telegraph and Trust	10	4½%	5½%	5½%	11¼— 11⅝	11¼— 11⅝	11⅝	11⅜
180,042	Do. do. 6 % Pref.	10	6 %	6 %	...	15 — 15½	15 — 15½	15½	15
150,000	Great Northern Telegraph, of Copenhagen...	10	10 %	12½%	...	32 — 34	32 — 34	...	...
86,300	Halifax and Bermuda Cable, 4½% 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	100 —103	100 —103	...	...
17,000	Indo-European Telegraph	25	10 %	10 %	10 %	53 — 57	53 — 57	55	...
100,000£	London Platino-Brasilian Telegraph, 6 % Debs.	100	6 %	...	...	105 —108	105 —108	...	...
72,680	Montevideo Telephone, Limited, Ord., Nos. 1 to 72,680 ...	1	...	...	...	¼— ⅛	¼— ⅛	...	...
86,492	Do. do. 5% Pref., Nos. 1 to 86,492	1	4 %	4 %	2½%	⅞— 1	⅞— 1	...	...
490,000	National Telephone, 1 to 490,000	5	6 %	6 %	5 %	4⅞— 5⅛	4⅞— 5⅛	4 1/16	...
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	13 — 15	13 — 15	13½	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	12 — 14	12 — 14	...	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	6 %	5 — 5½	5 — 5½	...	...
2,000,000£	Do. 3½ % Deb. Stock Red.	Stock	3½ %	3½ %	3½ %	98 — 101	98 —101	98	...
171,504	Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid	1	5 %	5 %	5 %	1 1/16— 1 1/16	1 1/16— 1 1/16	1	1 1/16
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000 ...	100	4 %	...	...	102 —105	102 —105	...	...
11,889	Reuter's	8	5 %	5 %	5 %	7½— 8½	7½— 8½	8 1/16	...
3,881	Submarine Cables Trust	Cert.	...	...	...	124 —129	124 —129	...	...
58,000	United River Plate Telephone	5	5 %	6 %	6 %	4½— 5	4½— 5	...	...
16,639	Do. do. 5 % Cum. Pref. Nos. 1—16,639	5	...	...	...	4½— 5⅛	4½— 5⅛	...	...
179,947	Do. do. 5 % Debs.	Stock	...	...	...	103 —106	103 —106	...	...
200,000£	West African Telegraph, 5 % Debs.	100	%	...	...	97 —100	97 —100	...	...
80,008	West Coast of America, Nos. 1—30,000 and 58,001—58,008	2½	...	...	...	½— 1	½— 1	...	...
150,000	Do. do. 4% Debs., 1—1,500 gua. by Bras. Sub. Tel.	100	...	...	...	100 —103	100 —103	...	...
389,731	Western and Brazilian Telegraph 4 % Deb. Stock Red. ...	Stock	...	...	...	102 —105	102 —105	...	...
207,980	Western Telegraph, Ltd., Nos. 1—207,980	10	7 %	7 %	...	14½— 15½	14½— 15	14 1/16	14½
75,000	Do. do. 5 % Debs. 2nd series, 1906 ...	100	...	...	...	105 —108	105 —108	...	...
88,321	West India and Panama Telegraph	10	2 %	2 %	⅝ %	⅝— ⅞xd	⅝— ⅞	⅝	...
34,563	Do. do. do. 6 % Cum. 1st Pref. ...	10	6 %	...	...	6½— 7½xd	6½— 7½	6½	...
4,669	Do. do. do. 6 % Cum. 2nd Pref. ...	10	6 %	...	...	6 — 7 xd	6 — 7	...	...
80,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	5 %	...	...	104 —107	104 —107	106	...

ELECTRICITY SUPPLY COMPANIES.

19,661	Brompton & Kensington Elec. Lt. Sup., Ord., 101 to 19,761	5	4 %	6 %	6 %	7 — 8	7 — 8	...	...
12,000	Do. do. 7 % Cum. Pref. ...	5	7 %	...	...	8½— 9½	8½— 9½	...	...
50,000	Charing Cross and Strand Electricity Supply	5	7 %	8 %	9 %	8½— 9½	9 — 10	9 7/16	...
20,000	Do. do. do. do. 4½ % Cum. Pref.	5	...	...	...	5½— 6	5½— 6	...	...
34,000	*Chelsea Electricity Supply, Ord., ...	5	6 %	6 %	6 %	6½— 7½	6½— 7½	...	...
150,000	Do. do. do. % Deb. Stock Red....	Stock	4½%	...	...	108 —111	109 —112	110⅜	110
60,000	City of London Electric Lighting, Ord. 40,001—100,000 ...	10	10 %	6 %	4 %	9½— 10½	9 — 10	9⅜	9½
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	...	12½— 13½	12½— 13½	12 13/16	...
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	...	...	124 —129	124 —129	...	...
40,000	County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—40,000	10	nil	nil	4 %	9½— 10½	9 — 10	...	...
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	...	11½— 12½	11½— 12½	...	...
200,000	Do. 4½% Deb. Stock, Prov. Certs (all paid) Rd. ...	...	...	...	...	110 —113	110 — 113	112½	...
26,100	Edmundsons Elec. Corp., Ord. Shares	5	5 %	7 %	...	4½— 5	4½— 5	4⅝	4 13/16
75,000	Do. do. 4½ % 1st Mort. Deb. Stock ...	100	...	...	...	101 —104	101 —104	...	...
110,000	London Electric Supply Corporation, Limited, Ord. ...	2	...	...	...	1½— 2	1 — 1½	1 1/16	...
49,840	Do. do. do. 6 % Pref.	5	...	6 %	...	4 — 4½	4 — 4½	...	...
250,000	Do. do. do. 4% 1st Mt. Db. Stock Rd.	Stock	...	...	...	100 —102	100 —102	...	...
85,000	Metropolitan Electric Supply, 101 to 62,500	10	6 %	5 %	5 %	13½— 14½	13½— 14½	14⅝	14
220,000£	Do. 4½ % First Mortgage Debenture Stock	...	4½%	...	...	114 —117	113 —116	...	...
220,000	Do. 3½ % Mort. Deb. Stock Red.	Stock	...	...	...	97 — 99	97 — 99	...	...
6,452	Notting Hill Electric Lighting	10	6 %	6 %	7 %	15½— 16½	15½— 16½	...	...
40,000	St. James's and Pall Mall Electric Light, Ord.	5	14½%	14½%	14½%	14½— 15½	14½— 15½	15	...
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	8½— 9½	8½— 9½	...	...
12,000	Smithfield Market Elect. Supply, Ord.	5	...	...	...	2 — 2½	2 — 2½	...	...
50,000	Do. Do. 4 % Deb.	100	...	...	...	85 — 95	85 — 95	...	...
65,000	South London Electricity Supply, Ord.	5	...	...	...	4 — 4½	3⅝— 4½	4	...
79,900	Westminster Electric Supply, Ord., 101 to 80,000 ...	5	12 %	12 %	13 %	13½— 14½	13 — 14	13½	13½

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.
Unless otherwise stated all shares are fully paid. ‡ Dividends paid in deferred share warrants, profits being used as capital
Dividends marked ‡ are for a year consisting of the latter part of one year and the first part of the next.

given by the Bank of England to the various municipal bodies which

the shareholders to adopt.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share.	Dividends for the last three years. 1897.	1898.	1899.	Closing Quotation June 6th	Closing Quotation June 13th.	Business done week ended June 13th, 1900. Highest.	Lowest.
		‡							
65,000	Aluminium shares, Nos. 1—65,000	1	10 %	20 %	...	2⅝— 3⅛	2⅝— 3⅛	2 1/16	...
90,000	Do. 4½ % 1st Mort. Deb. Stock Red.	Stock	...	...	...	96 —101	96 —101	...	...
30,000	British Electric Traction	10	...	6 %	...	15½— 16½	15½— 16½	16⅜	15⅞
50,000	Do. do. 6 % Cum. Pref.	10	...	...	...	12 — 13	12 — 13	12 3/16	12⅛
200,000	Do. do. 5 % Perpetual Debenture Stock	Stock	...	...	...	124 —127	124 —127	126½	...
85,000‡	†British Electric Works Co., Ord. £1 shares, 50,001—135,000	...	...	...	...	⅞— 1	⅞— 1	...	...
50,000	† Do. do. 6 % Cum. Pref., 1—50,000	...	...	...	...	1 1/16— 1 1/16	1 1/16— 1 1/16	...	...
500	† Do. do. 4½ % 1st Mort. Deb.	100	...	...	...	99 —101	99 —101	...	...
40,000	British Insulated Wire Ord., Nos. 1 to 40,000	5	15 %	15 %	20 %	11 — 12	11 — 12	...	...
27,500	Do. do. 6 % Cum. Pref. Nos. 1 to 27,500	5	...	...	...	6 — 6¼	6 — 6¼	...	...
90,000	Brush Elecl. Enging., Ord., 1 to 90,000	3	3 %	5 %	...	1⅝— 2	1⅝— 2	1⅞	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	6 %	6 %	...	2 — 2¼	2 — 2¼	2	...
125,000‡	Do. do. 4½ % Perp. Deb. Stock	Stock	...	...	...	109 —114	109 —114	...	...
50,000	Do. do. 4½ % 2nd Deb. Stock Red.	Stock	...	...	...	103 —105	103 —105	...	...
20,000	Callender's Cable Construction shares, Nos. 1—20,000	5	12½%	15 %	15 %	13½— 14½	13½— 14½	...	...
20,000	Do. do. 5 % Cum. Pref.	5	...	...	...	5½— 6	5½— 6	5⅝	5 7/16
90,000	Do. do. 4½ % 1st Mort. Deb. Stock Red.	Stock	...	...	...	112 —116	112 —116	...	...
213,533	Central London Railway, Ord. Shares	10	...	...	...	10 — 10½	10 — 10½	...	...
61,033	Do. do. Pref. half-shares	5	...	...	...	4⅜— 5⅛	4⅜— 5⅛	...	...
71,447	Do. do. Def. do.	5	...	...	...	5 — 5⅛	5 — 5⅛	...	...
855,000	City and South London Railway	Stock	1⅞%	2⅛%	1⅞%	65 — 68	65 — 68	67½	66
37,500	Do. do. Ord. shares, Nos. 22,501 to 60,000	10	...	...	...	6 — 7	6 — 7	...	...
32,098	Crompton & Co., Nos. 1 to 32,098	3	...	6 %	...	3½— 4	3½— 4	3 1/16	3⅜
100,000	Do. 5% 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 Red.	...	...	...	...	100 —103	100 103	...	...
99,261	Edison & Swan Utd. El. Lgt., "A" shares, £3 pd. 1 to 99,261	5	6 %	6 %	...	2 — 2⅛	2 — 2⅛	2	...
17,139	Do. do. do. "A" Shares, 01—017,189	5	6 %	6 %	...	3½— 4⅛	3½— 4⅛	...	...
344,023	Do. do. do. 4 % Deb. Stock Red.	100	...	...	...	93 — 95	93 — 95	...	...
112,100	Electric Construction, 1 to 112,100	2	6 %	6 %	...	2 — 2¼	2 — 2¼	...	...
25,000	Do. do. 7 % Cum. Pref., 1 to 25,000	2	7 %	7 %	...	2⅜— 3⅛	2⅜— 3⅛	...	...
140,300	Do. do. 4% Perp. 1st Mort. Deb. Stock	Stock	...	...	...	103 —106	103 —106	...	...
9,600‡	Greenwood & Batley, 7 % Cum. Pref., 1 to 9,600	10	7 %	7 %	...	10 — 11	10 — 11	...	...
30,000	Henley's (W. T.) Telegraph Works, Ord.	5	12 %	14 %	15 %	13½— 14½	13 — 14	13½	13¼
30,000	Do. do. do. 4½ % Pref.	5	7 %	7 %	...	5¼— 5⅜	5¼— 5⅜	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	4½%	...	...	110 —114	110 —114	...	...
50,000	India-Rubber, Gutta-Percha and Telegraph Works	10	10 %	10 %	...	21 — 22	21 — 22	21⅝	...
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	100 —103	100 —103	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	3½%	3½%	3⅜%	9¼— 9⅝	9¼— 9⅝	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	13¼— 13½	13¼— 13½	...	...
37,350	Telegraph Construction and Maintenance	12	15 %	15 %	15 %	34 — 38	34 — 38	36⅜	36
150,000	Do. 4 % Deb. Bds. Nos. 1 to 1,500 Red. 1909	100	...	...	...	102 —105	102 —105	...	...
20,000	Telegraph Manufacturing, Ord. Nos. 1 to 20,000	5	...	8 %	12 %	11½— 12½	11½— 12½	12	...
20,000	Do. do. 5% Cm. Prf. Nos. 1 to 20,000	5	...	...	...	5½— 6	5½— 6	...	...
540,000‡	Waterloo and City Railway, Ord. Stock	100	...	3 %	3 %	100 —103	100 —103	...	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

*Birmingham Electric Supply, Ordinary £5 (fully paid) 8—10.
Brompton and Kensington, 4½ % Debentures of £100, 103—106.
National Electric Free Wiring, 12/6 paid. ⅜—½.
Oldham, Ashton, and Hyde Electric (£10 pd.), Ord., 17½—18½.
Do. do. Pref. (£10 pd.), 10—11.
Kensington and Knightsbridge Electric Lighting, Ordinary Shares £5 (fully paid) 12—13; 1st Preference Cumulative 6 %, £5 (fully paid), 7 —7½. Debentures, 101—104. Dividend, 1899, on Ordinary Shares 11 %.
*T. Parker, £10 (fully paid), 17½.

* From Birmingham Share List.

Bank rate of discount 3½ per cent. (May 24th, 1900).

MARKET QUOTATIONS, Wednesday, June 13th.

CHEMICALS, &c.		This week.	Last week.	Inc. or Dec.
a Acid, Hydrochloric	per cwt.	5/-	5/-	..
a " Nitric	per cwt.	22/-	22/-	..
a " Oxalic	per cwt.	32/-	32/-	..
a " Sulphuric	per cwt.	5/6	5/6	..
a Ammoniac, Sal	per cwt.	39/-	39/-	..
a Ammonia, Muriate (crystal)	per ton	£34	£34	..
a " "	per ton	£31	£31	..
a Bleaching powder	per ton	£7	£7	..
a Bisulphide of Carbon	per ton	£15	£15	..
a Borax	per ton	£17	£17	..
a Benzole (90 %)	per gal.	7/-	7/-	..
a " (50/90 %)	per gal.	5/6	5/6	..
a Copper Sulphate	per ton	£26	£26	..
a Lead, Nitrate	per ton	£25	£25	..
a " White Sugar	per ton	£31	£31	..
a " Peroxide	per ton	£27 10	£27 10	..
a Methylated Spirit	per gal.	2/9	2/9	..
a Naphtha, Solvent (90 % at 160° C.)	per gal.	5/6	5/6	..
a Potash, Bichromate, in casks	per lb.	4d.	4d.	..
a " Caustic (75/80 %)	per ton	£24	£24	..
a " Bisulphate	per ton	£25	£25	..
a Shellac	per cwt.	68/-	68/-	..
a Sulphate of Magnesia	per ton	£4 10	£4 10	..
a Sulphur, Sublimed Flowers	per ton	£6	£6	..
a " Recovered	per ton	£5 10	£5 10	..
a " Lump	per ton	£5	£5	..
a Soda, Caustic (white 70 %)	per ton	£10 15	£10 15	..
a " Crystals	per ton.	£8	£8	..
a " Bichromate, casks	per lb.	8½d.	8½d.	..
METALS, &c.				
Aluminium Wire, in ton lots	per ton	£224	£224	..
b " Sheet, in ton lots	per ton	£191	£191	..
p Babbitt's metal ingots	per ton	£80 to £150	£80 to £150	..
c Brass (rolled metal 3" to 12") basis	per lb.	8½d.	8½d.	..
Tube (brazed)	per lb.	10½d.	10½d.	..
c " " (solid drawn)	per lb.	9d.	9d.	..
c " Wire, basis	per lb.	8½d.	8½d.	..
c Copper Tubes (brazed)	per lb.	11½d.	11½d.	..
c " " (solid drawn)	per lb.	11½d.	11½d.	..
Copper Bars (best selected)	per ton	£84	£84	..

METALS, &c. (*continued*).		This week.	Last week.	Inc. or Dec.
g Copper Sheet	per ton	£84	£84	..
g " Rod	per ton	£84	£84	..
e " (Electrolytic), Bars	per ton	£81	£81	..
e " " Sheets	per ton	£90	£90	..
e " " Rod	per ton	£84	£84	..
e " " H. C. wire	per lb.	9¼d.	9¼d.	..
f Ebonite Rod	per lb.	8/-	8/-	..
f " Sheet	per lb.	5/-	5/-	..
m German Silver Wire	per lb.	1/6	1/6	..
h Gutta-percha, fine	per lb.	8/- to 8/6	8/- to 8/6	..
h India-rubber, Para fine	per lb.	3/11½ to 4/1	3/9½ to 3/10	2d. inc.
i Iron, Charcoal Sheets	per ton	£18	£18	..
i " Pig (Cleveland warrants)	per ton	69/6	69/6	..
i " Forgings, according to size	per ton	From £11	From £11	..
i " Scrap, heavy	per ton	70/- to 72/6	70/- to 72/6	..
i " Wire galvanised No. 8	per ton	£13 5	£13 10	5s. dec.
g Lead, English Ingot	per ton	£17 2 6 to £17 7 6	£17 to £17 5	2/6 inc.
g " " Sheet	per ton	£18 10	£18 10	..
m Manganin Wire No. 28	per lb.	8/-	8/-	..
g Mercury	per bottle	£9 10	£9 10	..
d Mica (in original cases), small	per lb.	8d. to 9d.	8d. to 9d.	..
d " " " medium	per lb.	1/9 to 2/9	1/9 to 2/9	..
d " " " large	per lb.	3/3 to 7/3	3/3 to 7/3	..
p Phosphor Bronse, plain castings	per lb.	1/1 to 1/4	1/1 to 1/4	..
p rolled bars & rods	per lb.	1/1 to 1/4	1/1 to 1/4	..
p " r'l'd str'p & sheet	per lb.	From 1/3	From 1/3	..
o Platinum	per oz.	£3 12	£3 12	..
p Silicium Bronse Wire	per lb.	10½d. to 1/1	10½d. to 1/1	..
i Steel, Magnet, acc'd'g to desc'p'n	p. ton	From £15 to £40	From £15 to £40	..
i Steel, Magnet, in bars		£58	£58	..
g Tin, block	per ton	£140 to £141	£139 to £140	£1 inc.
g " foil	per lb.	1/9	1/9	..
n " wire Nos. 1 to 16	per lb.	1/9	1/9	..
p White Anti-friction Metals— "White Ant" brand	per ton	£40 to £70	£40 to £70	..
j Yarns, Cotton, Single 10lb. bundles	pr lb.	8½d.	8½d.	..
j " Best Flax, 6 lea.	per lb.	6d.	6d.	..
j " Hemp, 3 ply 10 lbs.	per lb.	4½d.	4½d.	..
j " " Russian, 10 lbs.	per lb.	5½d.	5½d.	..
j " Jute, 180 lbs. rove	per ton	£14	£14	..
k Zinc, Sheet (Vielle Montagne bnd.)	p.t.	£25 15 nett.	£25 15 nett.	..

Quotations supplied by
a Messrs. G. Boor & Co.
b The British Aluminium Company, Ltd.
c Messrs. Thos. Bolton & Sons.
d Messrs. F. Wiggins & Sons
e Messrs. Frederick Smith & Co.

Quotations supplied by
f The India-Rubber, Gutta-Percha, and Telegraph Works Company, Ltd.
g Messrs. James & Shakespeare.
h Messrs. Jackson & Till.
i Messrs. Bolling & Love
j Messrs. Henry C. Yee & Co.

Quotations supplied by
k Messrs. Morris Ashby, Limited.
m Messrs. W. T. Glover & Co., Ltd.
n Messrs. P. Ormiston & Sons.
o Messrs. Johnson, Matthey & Co., Ltd.
p The Phosphor Bronze Company, Ltd.

Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital
Dividends marked ‖ are for a year consisting of the latter part of one year and the first part of the next.

INSTITUTION OF ELECTRICAL ENGINEERS.

A FRICTIONLESS MOTOR METER.

By S. EVERSHED, Associate Member.

(*Abstract of paper read May 10th, 1900.*)

(*Concluded from page 987.*)

DESCRIPTION OF FRICTIONLESS METER.

The essential working parts of the author's meter are shown in fig. 2. The armature, A, brake dish, F, and train-driving coils, D_1 D_2, are mounted on a mild steel axle, *a*. The axle has a hard steel point at its lower end resting in a jewel cup, J; its upper end has no mechanical support, but is maintained in position by the magnetic attraction of an iron rod, B, which is magnetised by the brake magnets, M M, through an iron yoke, Y, and forms the supporting pole. The distance between B and the end of the axle is adjusted by screwing B in the yoke Y until the vertical force nearly suffices to lift the whole weight of the armature, brake, and other parts attached to the axle. The arrangement is more clearly seen in fig. 3, which is a section through the magnetic pivot. A magnetic pivot of this type may easily be made to support a weight of from 100 to 200 grammes.

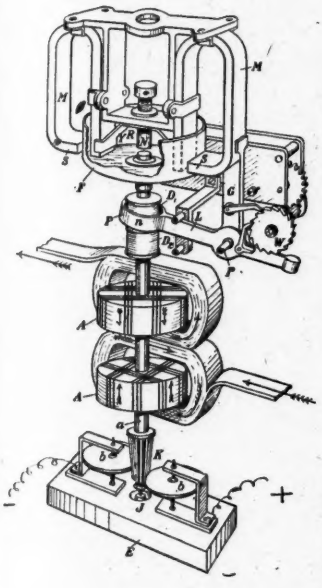
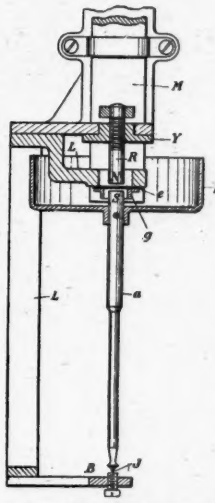


FIG. 2.—GENERAL ARRANGEMENT OF ASTATIC FRICTIONLESS METER.



M, Brake magnet; Y, iron yoke between the brake magnets; B, iron rod forming supporting pole, N; *a*, iron axle having upper end, S, beneath pole, N; *e*, end-plate (non-magnetic); *g*, guard ring to prevent axle from being displaced; F, brake dish; B, step bearing with jewel cup, J; L, axle bearing frame.

FIG. 3. — AXIAL SECTION SHOWING DETAILS OF MAGNETIC SUSPENSION IN A FRICTIONLESS METER.

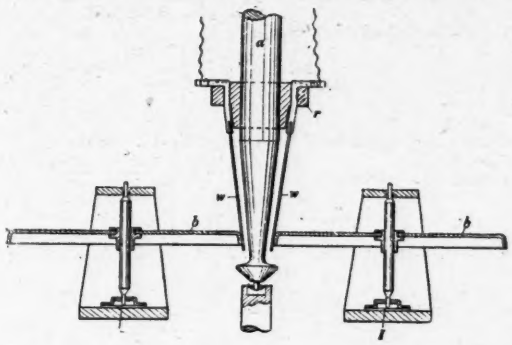
The commutator, K, is placed beneath the armature, and the wheel brushes, *b b*, are pivotted in frames attached to an ebonite plate, E. The commutator and brushes are shown on an enlarged scale in fig. 4. The segments are fine iridio-platinum wires supported at one end in an ivory collet and entirely free at the other end, where they impinge and roll on the brush wheels. The commutator is about 3 mms. in diameter at the rolling circle; the wheels are about 36 mms. diameter, so that they make one revolution to 12 revolutions of the commutator.

The pressure current is led to the brush wheels through their frames, and to ensure good contact between frame and wheel the step bearing of each wheel is an iridio-platinum pivot resting on a flat plate of the same metal.

A drum-winding is used for the armature, a break being made, in the ordinary course of winding, in each parallel, in order to insert the two little coils, D_1 D_2. Thus D_1 is in series with one of the two parallels of the drum-winding, and D_2 in series with the other; they are consequently each traversed by one half of the whole armature current, and since they are, electrically, a part of the armature circuit, the current in them is reversed twice in each revolution of the axle. D_1 and D_2 are inserted at corresponding points of the drum-winding, so that their currents reverse at the same instant, and they are coupled up so that the two currents flow in the same direction, and to all intents and purposes D_1 and D_2 behave like one coil.

Fig. 5 shows the connections of the train-driving coils in diagrammatic form, a Gramme winding being substituted for the drum for the sake of clearness.

Surrounding the train coils D_1 and D_2, but not touching them, is a ring of soft iron, P (fig. 2), forming part of an iron lever L, mounted on a horizontal axle, *p*. L is magnetised by induction from one of the brake magnets, an iron bar, G, serving to complete the magnetic circuit between S and *n*. The induction leaves the ring pole, P, and passes radially through the train coils into the axle, and P consequently experiences a vertical force alternately upwards and downwards as the currents in the train coils periodically reverse. The result is that L oscillates on its axis, making a double stroke or complete cycle once in every revolution of the armature. The motion of the lever is limited by stops, and is communicated by means of a pawl to a ratchet wheel, W, which is attached to the first axle of the counting train, T.



a, Axle; *r*, insulating collet; *w w*, iridio-platinum wires forming commutator segments; *b b*, brush wheels; I I, iridio-platinum bearing plates and pivots.

FIG. 4.—ELASTIC COMMUTATOR.

It will be seen at once that this device opposes no retarding moment on the armature axle. The only mechanical force called into play is in a vertical direction, and has no component tending to turn the axle. The train coils and magnetised lever form a reciprocating electric motor, and during the time the ring pole is moving up (or down) there is a back E.M.F. in the train coils, and the product of this back E.M.F. into the armature current and the time gives the consumption of electrical energy per stroke. It is, of course, equal to the mechanical work done—product of force on P into length of stroke. The force actually provided is far greater than that necessary to drive the train. The friction of an ordinary train is just overcome by a turning moment of about 4 dyne-cms. applied to the worm or pinion commonly used on a meter axle to gear into the first wheel of the train; 6 dyne cms. will generally keep a train running at a speed a good deal higher than anything save a short circuit can produce. The author has tested many trains taken out of different electric meters, and, curiously enough, they differ very little as regards friction.

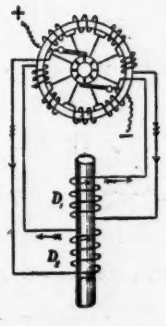


FIG. 5.—DIAGRAM OF CONNECTIONS BETWEEN ARMATURE AND TRAIN COILS.

Now if the train were geared to the axle in the usual manner, and required a moment of 6 dyne cms. to keep it going, the work done by the meter in driving the train being, of course, 2π times this moment in each revolution, would be about 28 ergs. The stroke of the train-driving lever is about 1·0 cm., so that the force upon it must be at least $\frac{38}{1·0} = 38$ dynes. The force actually obtained is about 750 dynes, which leaves an ample margin for accidental friction. It is assumed that the lever does no useful work on its return stroke.

A number of different forms of this train driver have been designed, and several of them have been tested in actual work. Fig. 6 shows a modification characterised by the same fundamental principle, namely, a coil producing an alternately upward and downward force upon the free end of a lever. In this modification the two train coils, D_1 and D_2 are coupled back to back, so that they produce a consequent pole in the space between them, and the movable coil attached to the end of the lever is alternately forced up and down. This coil forms part of the series resistance in the armature circuit,

and carries the whole of the pressure current. Fig. 6 is intended for alternate current meters, where a permanently magnetised lever would, of course, be useless.

The whole of the working parts of the meter, with the exception of the main current coils, are attached to a light framework, which is bolted to the top of the casting which forms the back, top, and bottom of the meter case. The other three sides of the case are formed by a bent sheet of zinc, which is screwed and sealed to the casting. The terminals project below the bottom and are covered by

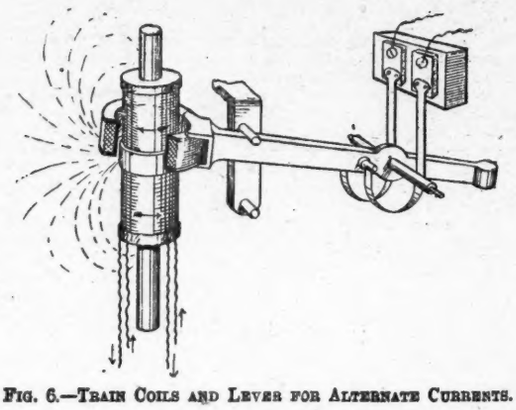


Fig. 6.—Train Coils and Lever for Alternate Currents.

an insulated box, which may be sealed after connecting up on the consumers' premises. The Foucault brake is in the form of a shallow dish, and the two brake magnets are fixed in positions which make it impossible for any excess of current in the main coils to demagnetise them. Their stray field is at right angles to that of the main coils.

Range of Frictionless Meter.

A meter in which frictional resistance is so small as 3 dyne-cms. will obviously have an unusually long range, even if nothing be done to correct the small remaining friction error. If the same limits are imposed as were assumed in making up Table I., namely, about 1 volt drop in the main coils and 3 watts wasted in the pressure circuit, the meter may be wound to give a maximum driving torque of 15,000 dyne cms. The friction is then only 0·02 per cent. of the full-load torque. The resulting range and uncorrected errors are set out in Table II.

Table II.—Errors of Uncorrected "Frictionless" Meter.

Maximum Driving Torque = 100, Friction = ·02. Full Speed = 100; Arbitrary units.

Driving moment M.	Friction f.	Speed numerically equal to M − f.	Percentage error.
·02	·02	0	inf.
·04	·02	·02	50
·10	·02	·08	20
·40	·02	·38	5
1·00	·02	·98	2
10·00	·02	9·98	·02
50·00	·02	49·98	·04
100·00	·02	99·98	·02

Standard range = 1 to 250.

It will be seen that the standard range of this uncorrected meter is 1 to 250. The range may be greatly extended by introducing a device to compensate for friction.

The author believes, however, that if advantage is taken of the enormous reduction in friction to improve the meter in other ways, even at a sacrifice of some part of the long range, a more generally serviceable instrument will be secured. An examination of the available statistics * shows that on an average about 50 8-c.p. lamps or their equivalent are wired per consumer. If we assume these to be 40-watt lamps, the maximum load of the average consumer will be about 2,000 watts and his minimum about 40 watts. Now the meter installed may be assumed to be wound for 2,000 watts, so that to register correctly at the smallest load the standard range may be reduced to 1 to 50.

A reduction of range enables us largely to reduce the power wasted in the armature circuit, but a limit to this reduction is imposed by the fineness of the wire it is possible to employ upon the armature and in the series resistance. On this account it is at present not advisable to reduce the pressure current below 0·01 ampere, and this value has therefore been adopted for all voltages. The waste of power in the armature circuit is then 1 watt for 100 volts, 2 watts for 200 volts, and so on. The voltage drop in the main coils may be left at 1 volt, this being only ½ per cent. on the 200-volt supply, which is now being rapidly adopted.

An additional improvement in accuracy has been secured by making the meter astatic, so that it is not affected by external magnetic forces.

* The author has made use of the excellent analyses published by *Lightning*.

Astatic Meter.

The astatic meter has its armature divided into two equal portions, placed one above the other, on the axle, as shown in fig. 2. These two parts, although physically separated, form one complete drum-winding connected to a single commutator. Following the process of winding a drum, the first coil will be wound on the lower spider; the second will be wound on the upper spider in exactly the same position as regards azimuth as it would ordinarily occupy if wound on the lower armature, but it is wound in the opposite sense. The third coil is on the lower spider; the fourth on the upper, and reversed in sense. Thus numbering the coils in succession, all the odd numbers will be found on the lower half armature, and all the even numbers will be found on the upper half.

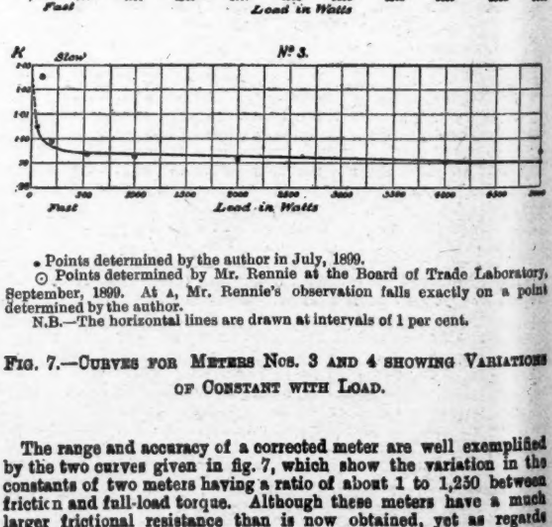
Each half armature is surrounded by its own pair of main-current coils, the two pairs being coupled so that the current flows in them in opposite senses, their magnetic fields being in opposite directions. This reversed coupling is, of course, necessary to drive both parts of the armature the same way, but it has the incidental advantage that it greatly reduces the stray field of the main coils, and so renders the brake magnets doubly secure against excessive currents.

The advantage of an astatic armature is, however, only gained at the cost of a reduction in driving torque, for the field in which the armature rotates is halved, although the number of turns on the armature itself remains the same as before.

The astatic meter is wound to give a driving torque of about 2,000 dyne-cms. at full load; the current in the armature circuit being 10 milliamperes, and the drop in the main coils 1 volt. The frictional resistance is about 2 dyne-cms. when the meter is new, and the tests to be presently referred to show that a frictionless meter will run for many million revolutions before any serious increase in friction takes place.

Compensation for Remaining Friction.

The initial value of friction is compensated for by means of a little strip of sheet-iron placed within the field of the main coils. When once magnetised by the main current, the coercive force of the iron is sufficient to provide the very small driving moment required to overcome friction. Compensation for friction will cause a meter to run at no load if it is subjected to vibration; but the elastic commutator has a directing moment upon the axle, which prevents the meter from running until the driving torque is two or three times as great as the moment of friction. Hence it is impossible for the compensator to start the meter or to keep it running. The corrected meter starts with from $\frac{5}{1000}$th to $\frac{1}{200}$th of full load, and has a standard range of about 1 to 200.



* Points determined by the author in July, 1899.
⊙ Points determined by Mr. Rennie at the Board of Trade Laboratory, September, 1899. At A, Mr. Rennie's observation falls exactly on a point determined by the author.
N.B.—The horizontal lines are drawn at intervals of 1 per cent.

Fig. 7.—Curves for Meters Nos. 3 and 4 showing Variations of Constant with Load.

The range and accuracy of a corrected meter are well exemplified by the two curves given in fig. 7, which show the variation in the constants of two meters having a ratio of about 1 to 1,250 between friction and full-load torque. Although these meters have a much larger frictional resistance than is now obtained, yet as regards accuracy and range they are very nearly identical with the astatic meter.

The larger friction in meters Nos. 3 and 4 arises from the fact that they were made before the adoption of the elastic commutator and other improvements. The frictional resistance in meter No. 3 is 7·9 dyne-cms., and the driving torque at full load is 10,000 dyne-cms. These meters are both slightly under-corrected. The Board of Trade

circuit between s and n. The induction leaves the ring pole, P, and

This coil forms part of the series resistance in the armature circuit,

limits are, however, nowhere exceeded throughout the whole range from 0 to 5,000 watts.*

TESTS FOR ENDURANCE.

Prolonged trial in actual service is, of course, the only conclusive test of the trustworthiness of any novel apparatus, but the tests to which the frictionless meter is being subjected show already that the mechanism has a remarkable power of endurance. Two meters had been made in 1898, and after many trials with different forms of commutator and train driving apparatus, in the course of which No. 1 meter had made between three and four million revolutions, the elastic commutator was fitted to this meter, and after preliminary tests for friction it was put on to a 100-volt circuit on May 25th, 1899. This meter has been running continuously since that date with the exception of the few hours occupied in making friction tests. The tests made up to the date of writing are given in Table III.:—

TABLE III.—FRICTION TESTS OF METER NO. 1. THIS METER WAS STARTED ON MAY 25TH, 1899, AND HAS BEEN RUNNING AT ABOUT 80 REVOLUTIONS PER MINUTE CONTINUOUSLY SINCE THAT DATE.

Date.	Total revolutions of armature axle.	Moment of frictional resistance. (dyne-cms.).
May 25th, 1899 ...	0	Not measured accurately, but about = 7 dyne-cms.
June 28th „ ...	3,460,000	6·8
Sept. 26th „ ...	12,275,000	6·8
March 30th, 1900...	29,046,000	7·2

The standard pressure current is 10 milliamperes, but for the purpose of this test it was raised to 18·2 milliamperes in order to make the energy running down in sparks upon the commutator when the train coils are reversed the same as it is with the standard size of train coil—No. 1 being fitted with a smaller train coil. During the first few weeks some sparking was visible, but this has gradually diminished, until at the present time sparks are only seen occasionally. There is no apparent wear either on the commutator wires or on the brush wheels. Platinum in the form of black powder clings to the inside of the wires, and has also settled in a ring round the axle inside the commutator; otherwise there is no visible change.

As soon as it was seen that the elastic commutator was a step in the right direction, No. 2 meter was similarly fitted, but with a commutator having much finer wires—about 4 mils. diameter—and with brass brush wheels lightly gilt upon their edges. After long tests with different pivots, during which time the elastic commutator made 3½ million revolutions, No. 2 meter was put on to the 100-volt circuit on October 12th, 1899, and it has been running at about 57 revolutions per minute day and night since that date. Periodical friction tests have been made, and the results are given in Table IV.:—

TABLE IV.—FRICTION TESTS* OF METER NO 2. THIS METER WAS STARTED ON OCTOBER 12TH, 1899, AND HAS BEEN RUNNING AT ABOUT 57 REVOLUTIONS PER MINUTE CONTINUOUSLY SINCE THAT DATE.

Date.	Total revolutions of meter axle.	Moment of frictional resistance (dyne-cms.).
Oct. 12th, 1899	0	3·2
„ „ „	100	2·1
„ 13th „	not noted	2·3
„ 16th „		2·4
„ 20th „		3·2
Nov. 7th „	2,088,000	2·9
„ 20th „	3,080,000	3·0
Dec. 21st „	4,313,000	2·9
Jan. 29th 1900	...	3·3†
„ 30th „	7,233,000	3·5‡

* For methods of measurement see Appendix.
† Commutator observed to be making irregular contact. After making test, examination showed a fine hair wound round and entangled in commutator. The hair was removed as carefully as possible without taking the meter to pieces.
‡ Taken immediately after removal of the hair.

No. 2 meter is fitted with a standard train coil, and the pressure current was therefore fixed at the normal value, namely, 10 milliamperes. No appreciable wear is visible on the commutator wires, but a curious change has gradually become apparent in the brush wheels. Where they roll in contact with the iridio-platinum wires their edges have acquired a smooth deposit of platinum, and under a magnifying glass they have the characteristic appearance of a surface which has been platinised by the ordinary electro-chemical process.

During these tests no adjustments or alterations of any kind have been made in the meters, nor have any precautions been taken to keep dust and dirt away from them. They are running in a dirty workshop with loose covers over them, and the slowly increasing friction noticed with No. 2 meter is probably due to the collection of dust—which is very visible—within the step bearing and in the brush wheel bearings. The normal speed at full load has been fixed at 50 revolutions per minute, so that No. 2 meter is running 14 per cent. and No. 1 meter 60 per cent. above full speed.

If we assume the average consumer to use the equivalent of 1·6 hours at full load each day, his meter will at the above speed (50 revolutions per minute) make 2,000,000 revolutions per annum. No 2 meter has therefore been subjected to wear and tear corresponding to five years' service, while No. 1 meter has run for a period corresponding to about 14 years. These figures are mentioned in order to enable the value of the tests to be estimated with some sense of proportion; they are not adduced as in any way a substitute for the test of hard work under all the varying conditions necessarily imposed upon supply meters in every-day use.

POSSIBILITY OF FURTHER REDUCTIONS IN FRICTION.

The results so far obtained, and an examination of the causes of the remaining friction, afford some ground for believing that its limiting value has not yet been reached.

It seems not impossible to reduce the 1·6 dyne cms. of total calculated friction to 0·45, or say 0·5 dyne cms., a reduction of 1·1. This should be subtracted from the lowest observed value of the frictional resistance in No. 2 meter, and would bring the initial friction in a new meter down to about 1 dyne cm.

The author is now investigating the behaviour of different kinds of step bearings for use in meters with a view to the determination of the type having the greatest power of endurance.

With an electric supply, energy is what the consumer wants, and what he pays for, and for lighting purposes he must have the energy supplied at constant pressure; hence the electric meter cannot be allowed to absorb more than a very small fraction of the energy and pressure of supply. It is clearly of the greatest importance that every cause of mechanical friction should be ascertained, and, as far as possible, removed. It was with this conviction that the author, quite in the early days of public electric supply, set about devising means for diminishing meter friction, and the outcome of a good many years of experimental work is the meter described in this paper. It is not claimed for it that it is in all respects the ideal of what a meter should be, but the author hopes it may be regarded as a step in the right direction.

NOTE.—The author desires to acknowledge his indebtedness to Mr. Cox, who has the charge of the experimental department at Woodfield Works. During three years' continuous work upon the meter Mr. Cox's fertility of resource and inexhaustible patience have surmounted many difficulties and led to numerous improvements. When it was decided to try roller brushes making elastic contact with the commutator, and some trouble was met with in producing rollers of the requisite elasticity, Mr. Cox proposed to have the rollers rigid and make the commutator wires thin enough to provide the necessary elastic rolling contact—an idea which has been adopted with the happiest results.

[In Appendices I., II. and III., the methods of calculating and measuring the armature and brake torque and friction are set out at length, with numerous data relating to these quantities.]

* Meters Nos. 3 and 4 are in use in the meter testing department of the Manchester Corporation as standards for checking the accuracy of other meters intended for commercial purposes, and the author is indebted to Mr. Wordingham for his permission to make use of the curves which accompanied the Board of Trade certificate. He desires also to thank Mr. Rennie, who very kindly supplied a copy of the tests made at the Board of Trade Laboratory.

ADDRESS TO THE NEWCASTLE-ON-TYNE LOCAL SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.*

(*Abstract.*)

(*Concluded from page* 989.)

IN connection with the coherer of the Marconi system which coheres in response to an electric flash, it is singular that Mr. Augustus Stroh has observed something akin in the adhesion of surfaces when traversed by an electric current.

It is said that, misguided by the *savants*, Prof. Hughes, the cruelly neglected scientist, did not go further in anticipating wireless telegraphy than as brought to light last year. Like Cavendish, it is a pity he did not publish his researches at the time.

Newcastle is famous for original work; well, first we have Lord Armstrong's hydro-electrical frictional machine of 50 to 60 years ago, showing the electrification produced by steam rushing through an orifice, and then we have Lord Armstrong's great work of 1897 on the "Electrical Movements in Air and Water." Second, in the order of date, comes Joseph Wilson Swan, F.R.S., of Newcastle-on-Tyne, the inventor of the Swan lamp, which assumed practical form in the autumn of 1880.

Mr. Swan himself laboured and experimented with the incandescent lamp in the decade 1850—60; he used carbon strips in loops and spirals carbonised in Wallace's Forth Banks pottery kilns in crucibles filled with powdered charcoal, but the available mechanical air pumps gave a bad vacuum for such a purpose. Yet, at this early date, Mr. Swan had grasped the necessities of the case, a cheap source of electricity, an excellent filament and a good vacuum.

Early in 1879 Mr. Swan brought some lamps to the historic Post Office battery room for measurement of current and resistance, when it was at once apparent that filaments made from cardboard parchmentised and carbonised were unsatisfactory, their resistance was low, the current absorbed was high, and the bulbs quickly blackened. At

* Delivered at the Durham College of Physical Science, May 15th, 1900, by the first Chairman, A. W. Heaviside, M.I.E.E., Superintending Engineer of the North-East (North) District of the British Postal Telegraphs.

these interesting and never-to-be-forgotten tests, Ohm's Law and multiple arc were much in evidence, all theory and experiments pointing to low resistance conductors and high resistance filaments as the solution of the domestic lighting problem.

The filament was the crux of the problem, and as late as April 3rd, 1880, after much work in the meantime taking four lamps as samples, their cold resistance was only 38, 45, 47 and 65 ohms, and 3½ amperes only made them red hot or a little more. But on June 15th, 1880, Mr. Swan gave me the pleasure of testing one of 120 ohms, and another of 118 ohms resistance.

This happier result was brought about by carbonising crotchet cotton, a true filament. After this Mr. Swan made such progress, that by the Autumn, Lord Armstrong's Cragside House was installed with 20 lamps; and on November 24th, 1880, Mr. Swan brilliantly illuminated the auditorium of the Institution of Civil Engineers in Great George Street, Westminster, to the delight of a distinguished audience of the members of the Institute of Telegraph Engineers and Electricians.

Mr. Swan, during these three years of labour, was running a neck and neck race with Edison and Lane Fox, each on independent lines, none the less honour to each of them; and all Newcastle men are proud of the distinction that in their city one of the most valuable inventions of the Victorian Era was conceived and developed to a practical issue by Joseph Wilson Swan.

Since then, at Bromley in 1885, Mr. Swan invented the cellulose, or nitro-cellulose filament squirted into a coagulating medium, such as alcohol, without which the high voltage copper-saving lamps of to-day would not be.

This material is also the basis of the artificial silk of to-day. It is now produced in a viscous form that can be moulded, enormously increasing its use in the arts.

It is worthy of remark that Swan foreshadowed the Faure pasted plate, which Lord Kelvin brought in a box from Paris containing a million foot-pounds of energy. At his lecture before the Literary and Philosophical Society of Newcastle-on-Tyne on February 2nd, 1879, when exhibiting a crude lamp, he spoke of the need for storage, and showed a modification of the Planté cell, in which there was the novel feature of spongy lead having been deposited around the frillings of the peroxide element previous to oxidation to form what is now called the + or positive element.

Swan's domestic lamp suggested a large incandescent lamp as a rival to the arc, and early in 1887 Mr. T. W. Edmundson, a disciple of Mr. Swan's, succeeded in making the sunbeam lamp, of from 100 C.P. to 500 C.P., or even up to 2,000 C.P., which, as a survival of the fittest, has managed to more than hold its own with its rivals. It is deserving of honourable mention as a Tyneside development, and, as in other lamps, the filament was the crux of the problem.

But to the Hon. Charles A. Parsons, the district has earned distinction by his invention of the turbo-generator. For the horse-power developed, it is, perhaps, the lightest machine in existence, occupying little space, perfectly elastic in its bearings, and said to cost little to mechanically maintain.

The first condensing turbine of the radial flow type was of 200 H.P. and at a speed of 4,800 revolutions per minute, drove an alternation of 150 KW. output. It was tested by Prof. Ewing, and the general result of the trials was to demonstrate that the condensing steam turbine was an exceptionally economical heat engine. With a steam pressure of 100 lbs., the steam being moderately superheated, and a vacuum of 28 inches of mercury, the consumption was 27 lbs. per KW.-hour, which is equivalent to about 16 lbs. of steam per indicated horse-power. This result marked an era in the development of the steam turbine and opened for it a wide field, including some of the chief applications of motive power from steam. At this period (1892) turbine alternators of the condensing type were placed in the Newcastle, Cambridge and Scarborough Electric Supply Company's stations, and soon afterwards several 600 H.P. of the non-condensing parallel flow type were set to work in the Metropolitan Company's stations, where the comparative absence of vibration was an important factor. Turbine alternators and turbine dynamos of 2 500 H.P. are now in course of construction in England and the United States, and larger sizes are in prospect.

A turbo-alternator manufactured at Heaton works, Newcastle-on-Tyne, for the Corporation of Elberfield, in Germany, was tested by a committee of experts from Germany, Prof. Ewing being also present, with the following remarkable results. At the full load of 1,200 KW, and with a steam pressure of 130 lbs. at the engine, and 10° C. of superheat, the engine driving its own air pumps, the consumption of steam was found to be at the rate of 18·6 lbs. per kilowatt-hour, an equivalent to a consumption of 11·9 lbs. per indicated horse-power, a result surpassing the records of the best steam engines in the production of electricity from steam.

The remarkable feature of the modern turbo-generator is its utilisation of the expensive force of steam in a series of steps by which its initial velocity of 2,462 feet per second is reduced to a final velocity of 405 feet per second, or one-sixth. Take a waterfall, it is theoretically possible to utilise the head without loss. Similarly, the fall could be used in a series of steps, the water losing its potential energy with each step. So it is with the turbo-generator. Take steam at a given pressure with a corresponding velocity, provide, as in the turbo-generator, a series of steam guide blades and a corresponding series of interposed blades for the steam to impinge upon, the diminution of pressure with each step being probably but ½ lb., the resultant circumferential velocity is one that is easily dealt with in practice, say, 2,400 revolutions per minute which allows direct coupling.

On the other hand, if all the energy is absorbed in one wheel, the resultant circumferential velocity gets beyond practical control. In the Laval turbine its 30,000 revolutions per minute must be reduced by gearing when practically applied; this limits security from breakdown to machines within and up to 100 H.P.; beyond that disaster follows. In the Parsons turbo-generator the centre of gravity of the moving mass coincides with the centre of the figure, or the geometrical centre of gravity, on account of the provision made for lateral displacement.

At the present time 10 large towns in this district, including Newcastle, Gateshead, Sunderland, South Shields, Tynemouth, Wallsend, Middlesbrough, Stockton, Darlington and West Hartlepool, have either electric-power houses in active operation or in course of rapid construction. In Newcastle we have two services, that of the Newcastle and District Electric Lighting Company, projected by the Hon. C. A. Parsons, late in 1888, and that of the Newcastle-on-Tyne Electric Supply Company, projected by Dr. Robert Spence Watson in 1881, but not brought to a practical issue until 1888. The original turbo-generators are employed at a speed of 4,800 revolutions; the later machines only 2,400 revolutions, with a pressure of 1,050 volts and a frequency of 80 periods.

Last year the company generated 1,571,650 units, sold 963,622 units, and the peak reached 756 amperes upon an installation of 1,490,130 watts, the number of consumers being about 400.

The Newcastle-on-Tyne Electric Supply Company's plant is the very antithesis of that of its companion company, the "District," where, as described, it is light, having velocity and elasticity in lieu of momentum or inertia of mass.

That of the "Supply" is slow moving and heavy. Horizontal compound long-stroke Corliss engines of 70 to 80 revolutions and Mordey dynamos up to 150 KW. each.

The engines, which are of Robey & Co.'s well-known make, and fitted with their trip expansion gear, have performed admirably; during the 11 years' working no main bearing cap on any engine has been lifted, and no new part has been supplied, excepting piston rings, and all the engines are now in first rate working condition. The steam consumption may be said to average 16 lbs., with the low vacuum of under 20 inches, the larger units, of course, giving the best results. Similarly, the Mordey uniphase dynamos, 2,100 volts, have been equally successful. They are nearly self-regulating, the larger units being the most satisfactory. As is well known, they are remarkably efficient, having the characteristic of steadiness under all loads.

In 1899 the company generated 1,517,311 units for the supply of an installation of 1,924,680 watts, reaching a peak of 416 amperes upon a sale of 990,551 units, the number of consumers being nearly 1,000.

Both companies use rubber cables, the "District" using a complete network of high tension single cables in iron pipes, and the "Supply" a network of concentric cables in iron pipes. Rubber insulated cables, if not starved, and treated properly, either wholly concentric, or wholly single pairs in a uniform atmosphere and a uniform mechanically protective environment, give little trouble. Both companies have cable 10 years old still doing excellent service.

Both companies are developing direct low tension services in congested places.

Dr. Watson's Company has two accumulator sub-stations, one in operation, another on the eve of practical employment. They are experimental. If successful, both technically and commercially, they will mark an important step. Accumulators may be charged when there is no other use for the machinery, and employed to take the peak off. The transformation losses are roughly comparable with the transformation losses in central distributing power house schemes.

Though so divergent in system both companies' commercial success is nearly the same.

On the distribution side of the question there is a danger. A large central power house, if there is to be economy, means high pressure alternate current transmission of, say, 50 periods uniphase, if it will do (by no means improbable in the near future), and more phases if it will not, to as near the point of consumption as possible, large low tension services are to be deprecated, especially where coal is cheap. The fewer the transformations the better, and preferably of the static, than of the dynamic order. In other words, do not have moving parts demanding human watchfulness, except where it is imperative, as for straight currents for electro-chemical work. Alternating currents needing no brushes will do all the rest. Simplicity is what is wanted, not complication.

With reference to electric traction, I would like to express my unqualified condemnation of the extremely short-sighted policy of not starting with a double track right away in the busy towns of this district.

It is only excusable when there is lack of width, and that is rare.

The result of a circular I sent out to ascertain the number of persons employed on electrical work in this district gives the following approximate figures:—

Telegraphs and telephones	3,900
Electric supply companies	335
Manufacturers	2,400
Installers	219
Sundry Employment	146
	7,000

THE ELECTRIC SHOCK FATALITY.

ON Saturday the Wolverhampton Borough Coroner (Mr. R. A. Wilcock) resumed the inquest at the Town Hall respecting the deaths of Daniel Trawford and Samuel Clulow, who, as stated in the ELEC-

TRICAL REVIEW of last week, were killed by an electric shock at Mars Ironworks, near Wolverhampton, on May 31st. Messrs. George Adams & Sons, Limited, the proprietors of the works, were represented by Mr. Wright, solicitor, and Mr. F. J. Sharpe appeared for the relatives of the deceased men. Mr. Ashworth, factory inspector, was also present.

SAMUEL MEREDITH, a bar weigher, of High Street, Sedgley, said that he was working at Mars Ironworks on the night turn on May 31st. At about 10 o'clock he saw Clulow lying on his back in the cabin, with his left hand on a wire which was used to draw an arc lamp up and down. As he (witness) stooped down to pick Clulow up his hand touched the same wire that deceased had hold of. He received a shock which went right up his arm. He ran away and raised an alarm. Witness had caught hold of that particular wire "many a time," and he had seen others do the same. He did not know there was any danger.

By Mr. SHARPE: It was possible to go past the wire without touching it. On the night named witness touched it accidentally. He had not heard of other men having had shocks from that wire.

GAIUS MARSON, puddler, of Bristol Street, Sedgley, stated that on hearing the alarm he ran towards the cabin. When about a yard away from it he was just going to take hold of Trawford, who was lying beside Clulow. He heard a shout, "Don't touch him!" so witness left the body alone.

ROBERT JONES, roller, of New Street, Ettingshall, stated that when he tried to pick up one of the men he had a shock. By Mr. Wright: He did not notice that the two men as they lay on the ground were touching each other.

THOMAS FELTON, night manager, in his evidence stated that he saw Trawford lying partly across Clulow. Both were perfectly still. A man named Dodde turned off the current at his request. At the hospital the doctors tried to restore animation, but failed. The installation was put in the works about last November. By Mr. Ashworth: None of the workmen, to his knowledge, had had instructions in first aid. He had not seen any printed notices in the works calling attention as to how to restore people who had received electric shocks. He did not know that in electric installations of high pressure there were printed regulations showing workmen how to restore animation in cases of shock.

Mr. JOHN BAKER, of Wanderer's Avenue, the electrical engineer who placed the installation in the works, said there were 18 arc lamps of 10 amperes at 50 volts each. The arc lamps were made by the Brush Company, of Loughborough, and were purchased secondhand. They were bought under his advice. He could not say how long the lamps had been in use before his firm bought them. They had had a lot of wear. He did the repairs himself. The light was made by an engine driven by steam on to a dynamo. The conductor was of stranded copper wire, insulated with india-rubber and braided. On the 31st ult. 14 lamps were being used. That night he left the works at 9.30, so that after his departure there was no one about with any special knowledge of electricity. He had to return to the works at 11.30, but on that night he was fetched before that time. He did not make any inspection that night, and everything was left as it was until yesterday (Friday), when the experts visited the place. He could not form any opinion as to how the accident occurred. He did not know how the current could have got down the wire in question. Witness had had no training; he got his electrical knowledge out of books and from one man, an electrical engineer of Walsall Wood, under whom he worked for about four months. He had put one other installation in a works before this one. That previous one worked at a pressure of 110 volts. He had not had any experience before with a direct current machine such as that belonging to Messrs. Adams & Sons, Limited. He worked the machine according to printed instructions given by the Brush Company. The previous machine he had worked was a compound wound. The maximum voltage when all the lamps were on was 900 volts. The machine would carry 25 arc lamps, and if those were in use they would be worked by 1,250 volts. The 14 lamps which were used on the night in question were worked at 700 volts. The conducting wires were carried through brick walls, which he now knew to be inadvisable.

The CORONER: You would not do that again, would you?

WITNESS: No, sir.

Continuing, WITNESS said he failed to notice any connection of current between the arc lamps and the wire which was touched.

Questioned by Mr. SHARPE, WITNESS said the men evidently came into contact with a pulley wire, which at the time, from some cause he could not explain, was alive with electricity.

Mr. SHARPE suggested that on the top of the lamp porcelain should be used instead of wood.

WITNESS agreed that it would be better to have a non-combustible substance.

Mr. SHARPE: Has not the wood a tendency to bring about intermittent leakages of the current?

WITNESS: I should not say anything about it; I do not know.

In reply to Mr. WRIGHT, WITNESS stated that the book of instructions he had did not explain the mechanism of the installation.

The witness MARSON was recalled, and said that before Trawford went to Clulow's assistance, he saw a few sparks about the cabin floor.

ARTHUR HENRY DODD, who was in charge of the engine which drove the dynamo, said that at the time of the accident there was a voltage of 700. He had no practical knowledge of the installation, but he was supposed to be in charge when Baker was away.

Mr. LEA, electrical engineer, Birmingham, said he was not able to offer any explanation as to how the accident happened.

Mr. W. H. THORNBURY, consulting, mechanical and electrical engineer, of Birmingham, said that the previous day (Friday) he had made an inspection of the spot in the presence of Mr. Lea. The wire in question had nothing whatever to do with the electrical system, and it ought to have been completely insulated from the system.

The CORONER: Can you form any theory as to how the accident occurred?

WITNESS said he had a theory, but he would not say it was a correct one. On Friday afternoon he was much puzzled, but at an early hour that (Saturday) morning he had made up his mind. His theory was that one of the tests made showed there was an electrical connection between the lamp and the steel (pulley) wire. If that was the case at the time of the accident that wire must have been alive, and any person standing on the ground and taking hold of that wire, if there was a leakage to the ground at some distant part of the system, the person grasping the wire would sustain a shock.

The CORONER: Could you find where the leakage had taken place?

WITNESS: We could not find on Friday afternoon that any such leakage existed. He therefore came to the conclusion that the conditions during the test could not have been exactly the same as when the accident happened. He was inclined to think that when the accident happened a lamp at some distance away was also at the time leaking to the earth through its suspension wire, which might have occurred by the weight on the suspension wire touching the earth or an iron column.

The CORONER said that the leakages going through the earth would form a circle.

WITNESS condemned the carrying of connecting wires through holes in walls, because the friction, in time, would wear the insulators away. It was not customary, and it was inadvisable to use such high voltage in a works for lighting purposes. There were systems of low voltage which might be used with perfect safety. He should recommend Messrs. Adams & Sons, Limited, to have the installation reconstructed.

By Mr. WRIGHT: He might take it that there was no defect in the system, except an earth current from the lamp in question. He made a six hours' examination, but found only one defect. After the lamp had been taken down, examined, and put up, no connection between the system and the pulley wire was seen. The result of the tests did not reveal that any other lamp was defective.

Mr. LATCHFORD, assistant house surgeon at the Wolverhampton General Hospital, said that, from what he saw, he could not say anything definite as to the cause of death, but the appearance of the bodies was compatible with death from electric shock. The current, according to its strength, affected the heart or the nervous centre. If it affected the latter, and artificial respiration was performed, the nervous centre might, in certain cases, recover from temporary suspension.

The CORONER, in summing up, said Baker had endeavoured, no doubt, to make himself acquainted with electrical knowledge, but his experience had not been great. He did not, however, think the jury could find in the evidence anything to justify them in finding any person guilty of criminal negligence.

A verdict of "Accidental death" was returned. The jury suggested the present system of high voltage should be discontinued; if retained, the wires should be placed out of reach.

During the hearing of the case, Mr. Wright stated that there would be no question of compensation raised. The men were injured at the works, and compensation would be paid. The amount remained to be ascertained.

OUR LEGAL QUERY COLUMN.

[*Questions addressed to the Editors for insertion in this column should be as brief and concise as possible. Free use of fictitious names, &c., may be made. Answers are furnished by a duly qualified lawyer, but the Editors cannot undertake to be responsible for the accuracy of the views which he may express.*]

SALVATOR VIAE writes: "A discussion has recently arisen in this town between the Corporation and the electric tramway company as to whether the company is liable, and, if so, under what order and statute, to keep their track 'sanded' in wet or frosty weather. It is obvious that to lay sand or gravel on the track is an unnecessary expense in the case of a system where electric traction is made use of. Hence the company in question omit to do that which in the case of horse traction is practically essential. Frequent complaints having been made of accidents which are occasioned by the slippery state of the paving setts, the Corporation are anxious to know (*a*) whether the tramway company can be held responsible for such accidents; and (*b*) by what means (if any) they can be compelled to lay down gravel or sand when occasion requires."

*** In the absence of any reference to the terms of the provisional order under which the electric tramway company in question have power to run trams and maintain track, we are only able to give the following general answer to the question put to us by "Salvator Viae."

It is provided by the Tramways Act, 1870 (33 and 34 V., c. 78, S. 28), that promoters shall at their own expense, with such materials and in such manner as the road authority shall direct, and to their satisfaction, so much of any of the road whereon any tramway belonging to them is laid as lies between the rails of the tramway, &c.

By Sec. 55 of the same Act it is provided that the promoters, or their lessees shall be answerable for all accidents, damages and injuries happening through their act or default . . . . or in consequence of any of their works . . . . &c. There is nothing in the Tramways Act, which makes it compulsory upon the company to place sand upon their track, and, indeed, we are not aware that any

such duty is placed, even upon the road authority, by any of the Highway Acts. In fact the matter is only referred to in the Towns Police Clauses Act, 1847, where it is enacted in Sec. 28 (after providing against the acts of persons who obstruct the highway) that it shall not be deemed an offence to lay sand or other materials in any street in time of frost to prevent accidents . . . . if the party laying any such things causes them to be removed as soon as the occasion for them ceases. In all the Acts which we have been able to consider there is nothing which casts a duty upon the road authority, or upon any persons or body of persons upon whom the repair of the highway or any part thereof is for the time being imposed to lay sand in the streets. In answer, therefore, to question (*a*) we are of opinion that the company could not be held responsible for such accidents. With regard to (*b*), if neglect to lay sand could be included under the heading "neglect to repair," the remedy of which the Corporation could avail themselves, would be by indictment. As we have seen, however, there is nothing in the Acts which would justify its inclusion under the heading "repair."

We are advised that the interesting point raised by "Salvator Vise," has recently formed the subject matter of a case in Ireland, in which the Court reserved judgment. When published, the effect of that decision will be duly noted in these columns.

THE EDUCATION OF MACHINISTS.

American workshops appear to be chiefly short of good foremen, if we are to judge by a recent paper by Mr. Higgins before the American Society of Mechanical Engineers. As he rightly says, the real skilled workman, able to turn out a first-class piece of work, is by no means the best man to make a foreman. What Mr. Higgins requires is a grade of trained men who are not up to the standard of what he terms mechanical engineers, but are yet capable managers and capable of arranging work in the shops and carrying it out on paying lines.

What, he asks, are the common and other schools, secondary to the technical schools and colleges, doing for the education of those boys, from whom the mechanics of the near future must be made? The educational reports of 1897-8 show that, taking the common schools as a basis, 80 per cent. of the pupils drop out prior to the high school, and 97·5 per cent. before graduation from the high school. But the average high school graduate, after 10 years of continuous work, cannot earn his living as the result of anything he has learned in school. He must now begin to learn how to do this; out of over 16,000,000 pupils only 165,000 appear on the rolls of the colleges and universities. Yet it is believed that a large proportion of boys who leave school after four or five years would continue longer, say to the age of 16 to 20 years, if such longer period would enable them at once to become earners. It is a matter of general opinion that life's work should be begun early, as the receptive period is that under the age of 20. With other Americans, Mr. Higgins considers that the technical schools have failed to reach the class he has in mind. They teach science rather than technics, aiming apparently to produce captains where privates are in demand, and the students in American Technical Colleges are falling off in number at a rate greater than can be accounted for by the present prosperous times. This is attributed to the very stiff standards of admission required, standards that grow stiffer and not easier, and which appear to us to be entirely due to the wish of the teaching element to regard themselves as officers of high-class colleges rather than the servants of a technical school. One institution sets itself against another in an unhealthy rivalry that requires the restraining influence of outside control. The same spirit has made for our English primary schools hot beds of false sentiment, and half our social troubles to-day arise from a wrong conception of their duty by the Board School teachers of Great Britain.

Prof. Thurston, speaking of America, says that the process of raising entrance requirements has already gone too far, for purely sentimental reasons, that do not appeal to the people who desire to send their sons to such schools. The above we believe to be a very true indictment, and it points to what ought to be avoided by our own schools. By aiming so high, it is of course obvious that the masters must be numerous, and to produce one good engineer, a hundred who might be good mechanics are spoiled, while at the very start they had not in them the making of engineers. The fault lies in training a boy for a level he is unfitted to occupy, and he feels a reluctance to go down in life to a lower grade. To our way of thinking, the maximum of harm has come out of the premium apprentice system. Large works have refused any apprentice that could not pay his premium of £50 to £150 annually. The locomotive engineers of the big railways have been the original offenders, and have done their best to encourage a class of premium apprentice who, so long as he paid, could loaf all day, and was finally pitchforked into some colonial appointment, to the great disaster of English trade in the long run.

We have seen such men abroad armed with copies of the drawings of the firms with whom they served their time. All the locomotives they asked for would be rigid copies of this one firm's make, for they looked to the parent firm to help out their own ignorance. But for the premium apprentice there would have been no failure of the old system.

Germany is said to be overflowing with useless polytechnic graduate engineers, and the same tendency rules there for gradually raising the standard of a school. The manual training is continually neglected.

Our author cites as an example of the evil he deplores the Worcester Polytechnic Institute. In 1884 the mechanical engineering course was three and a half years. In 1896 it was four years. In 1884 shop work occupied 2,376 hours. In 1896 it was only 1,709 hours. In 1884 a year's work was 42 weeks. In 1896 only 36 weeks. These short years are all very well for the professors and serve admirably for book production no doubt, but such book production is only so much more robbery of the unfortunate parents of the boys.

There must always be some scientific engineers, men of high attainments, who are really above and beyond machines, processes, or costs. Such men will not always make money. They will discover new laws; they deal in pure science. Such men are, we may say, indispensable to the progress of the world. But all cannot belong to this high class, and need not envy the favoured few who do rightfully find a place in its ranks, and it is not sound teaching to aim at making scientists of all who join a technical school.

Mr. Higgins's solution of the difficulty is to produce many well-trained and educated machinists, and from these some foremen; from the foremen a few superintendents, and an occasional engineer. He advocates a half-time school, which shall first include a commercially successful and productive machine shop, co-ordinate in importance, influence, and educational value with the academic side. This department must claim the pupils during half the working hours on five days of each week for four years. The academic side is to consist of the other half of the pupils' time spent in the public schools on the equivalent of a high school course modified to meet the pupils' needs.

The management is to be by trustees, who shall be practical men of business. The duration of the scholastic course, and the beginning of actual work is to be determined on no hard and fast lines, but by a pupil's endowment, so that when he does stop his scholastic course he has had the best training possible for his career as machinist, draughtsman, foreman, or manager.

If specially apt he may go on to higher flights, but wherever he may stop he will not have wasted any time so far, nor cut himself adrift from the higher education that may still be built upon the foundation thus far laid. Mr. Higgins would begin the process of selection at the bottom, and proceed upwards rather than as now proceeding from above downwards. There would be less disappointment, and an early stop due to want of further capacity would not be written as a failure. Those who became engineers would have had the same training and more than the mechanics, and would not be as officers learning the drill from their men.

Of course, the great difficulty is to set up a productive school shop. We all know of large engineering shops which pay dividends out of their many premium apprentices, but how is the school shop to be really productive so that it may put a line of pumps or engines on the markets? Here is an undoubted difficulty. The pupils of one school would be all versed in one article, for it would be impossible to do general work. Another difficulty would be that the tools would be, necessarily, for teaching purposes of great and, perhaps, uncommercial variety. Our author says the shops must be such that hired men can be employed if desirable to the extent of half or a third of the total of students.

Herein lies the danger that a managing trust would want to run the shop on too paying a basis, and depart too far on commercial lines. The hired contingent ought to be strictly limited and particularly expert. Mr. Higgins is confident as to the entire practicability of the commercial shop. Hitherto the school shops have been shops of instruction, not of construction. Only on the latter lines can they really teach a boy how to work. Practically, the school shop is to form as nearly as possible a copy of the old system of apprenticeship. Obviously, it cannot teach what all boys long for—the experience on outside jobs which is so necessary to the training of an engineer. If some such outside practice could be added by some system of hiring out the pupils in their third or fourth year on actual outside work, a great advantage would be gained. Mr. Higgins's school would train machinists no doubt, but it would not train engineers quite so fully as necessary.

The example of the medical and surgical professions is cited in support of the shop school. Students do not play at medicine or at surgery, but perform real operations, get over real difficulties, and *save patients' lives* (the italics are ours). How the above naïve remark calls up the familiar "Experimentum fiat in corpore vili!"

But in addition to teaching the pupils to do work, the school shop must teach them to do it economically. Management must be a feature in the curriculum—at least, for those who can go so far. The lack of commercial training is the one thing that the old style of apprentice had to deplore. Firms would not let him into the office. They feared no doubt to show up profits to the outer youths, and so to induce too keen a rivalry. Mr. Higgins would make the department of costs one of importance.

The standard of excellence must be high. It is never necessary to lower this because boys are to do the work. Indeed, it is easier to instil accuracy and the need for it into students than into journeymen. Boys will not fail in the quality of what they turn out so much as the quantity. Nor do students spoil tools or material.

No shop practice should be less than half a day in duration, and each first half day must be followed by a second. Thus the student who starts shop work at 1 p.m. on Monday will continue until the same hour on Tuesday with, of course, a night's rest between, and his next spell of shop work will be from Thursday, 1 p.m., to the same hour on Friday. He will not have any scholastic work in the evening between his periods of shop work.

Mr. Higgins hopes that the system he advocates would sift our men of ability while boys. It can hardly be deemed an economy of material that the man who knows most about a certain important department in a certain factory was a hod carrier when that factory was building, or that the head of another department was snagging castings eight years ago. At the same time, it cannot be denied that certain men who are fitted to-day for their positions had not the capacity to be trained for these positions ten years ago. Men are so constituted that they develop

at very different ages. It can never be foretold at what age, if at all, the brain will begin to develop fresh convolutions; but it is certain that different brains have different ages for development, and it may be that after all a period of hod carrying was the best possible training in the case above cited. Finally, as a substitute for entrance examinations, which have simply developed a class of boys who are experts in passing examinations, our author would supplement an actual investigation into the boys' habits of life and study.

ADMIRALTY ENGINEERING.

IV.

The *Engineer* concludes this series by blaming the Admiralty for having condemned the Scotch boiler on insufficient grounds. They fired the boiler, crammed as it was with tubes, with forced draught from closed stokeholds, and, of course, caused the tubes to leak. The Admiralty then put ferrules in the tube ends, and there their energies died out. They could not see the error of the closed stokehold, and refused to use the closed ashpit, a recent example of which is cited on the P. and O. liner *Egypt*, an 8,000-ton ship with 9,000 H.P. engines, and fitted with eight double-ended boilers for 180 lbs. pressure. Each boiler has three furnaces, and forced draught to 1½ inches is employed. After three years of work there has been no trouble. Yet the Howden system, which secures this desirable condition, has not been looked at. The Admiralty have preferred to pay nearly £200,000 to France for a boiler.

In one respect we differ from our contemporary, which holds that there was sufficient evidence to justify at least a trial of the Belleville boiler. We cannot endorse even this mild defence. How could there be, from the very construction of the boiler.

It appears that even Welsh coal can only be used on its grates by men who have been trained specially to fire it. Was not this also apparent? Air-compressing engines have had to be provided to send jets of air between the tubes to help combustion.

Why, asks the *Engineer*, did all the Admiralty eggs go into one basket? Was not one vessel enough as a test? Had the *Powerful* been run on a six months' cruise for experiment alone, her boilers would probably have been the last Belleville boilers in the British Navy.

Why, it is asked, if the water-tube boiler was desirable, was no other boiler given a fair trial?

The *Minerva* has Scotch boilers. Her sister ship, the *High Flyer*, has Belleville. The former has developed 9,000 H.P., the latter 10,000 H.P., so that their trials have not been inadequate. On three runs of 60 hours at 10 knots the *Minerva* burned 27 per cent. less fuel than the *High Flyer*, which latter had 100 leaking joints to make good, and required five days to be ready for sea again. On two runs of 60 hours each, at 14 knots, the water-tube ship burned 22 per cent. excess of fuel, and required six days to be ready for sea again, but the *Minerva* was ready at once.

On the third trial of two runs of 60 hours at 17 knots the *Minerva* burned 613 tons against 663 of the Belleville-boilered ship. On a fourth trial 358 and 375 tons were respectively consumed. On a 30 hours' full load test the *Minerva* burned 225 tons; the *High Flyer* 267, or 18 per cent. more, and is now under extensive repair. The *Engineer* has not much to say as to the future boiler, but anticipates it will have straight and steeply-inclined tubes of moderate diameter. The Yarrow is one of this type. For 800 H.P. a Yarrow boiler weighs 11 tons, and a Belleville boiler weighs 35 tons. Such boilers as the Yarrow have been fitted by Russia, Holland, Portugal, and by the Elswick people, and third-class vessels of our own Navy of the *Pearl* class have had various other types of small tube boilers fitted.

Finally, the summing up is that the Scotch boiler has been condemned on inadequate grounds, and that it failed owing to faulty design and a wrong system of working. That the Belleville boiler deserved a full trial, but was adopted on insufficient grounds, and no ship ought to be now fitted with it, and it is held that Niclausse, or improved Babcock boilers, are full of promise. Further, a considerable addition should be made to the engineering staff of the Admiralty. While improving the position of the engineers as such, the country should see to it that the incompetents are weeded out. As we have already said, we cannot afford to imperil the country for the sake of the favourites of influence; our engineers must be prepared for the most arduous duties, they must be paid for it, they must be put into a position of responsibility and expected to live up to it.

INTERNATIONAL ELECTRICAL CONGRESS AT PARIS, AUGUST 18th to 25th, 1900.

The following programme of questions to be discussed at the meetings of the Congress has been adopted by the Committee of Organisation. The first meeting will take place on Saturday, August 18th, at 10 a.m., at the Palais des Congrès.

PROVISIONAL PROGRAMME.

Section I.—Scientific Processes and Measuring Instruments.

1. *Magnitudes and Units.*—Recapitulation and co-ordination of the decisions of former congresses.

2. *Methods of Measurement.*—Methods of testing materials and the specification of their properties:—Insulators, conductors; magnetic substances.—Measurement of magnetic fields.—Measurement of the power of simple and polyphased alternating currents.—Practical methods of decomposing a periodic curve into simple harmonic functions.

3. *Measuring Instruments.*—Recent improvements in measuring instruments.—Wattmeters.—Meters.—Phasemeters.—Hysteresismeters.—Oscillographs and rheographs.

4. *Photometry.*—Secondary standards; comparison of photometric standards.—Measuring methods and instruments.

Section II.—Production of Electrical Energy—Transformation—Transmission and Distribution—Electric Traction—Lighting.

1. *Production of Electrical Energy.—Transformation.*—Progress made in continuous current generators as regards the lead of the brushes.—The unification of modes of testing and definitions relating to machines. In particular, the definition of maximum current, normal power, fall of pressure, and elevation of temperature.—Comparison between inductor alternators and other types.—Unification of frequencies; discussion as to the best frequencies to adopt, with regard to price and good working of the apparatus.—Compounding of alternators.—Asynchronous generators.—Coupling of alternators: influence of the regulation of the prime motor.—Commutators, rectifiers.—Price of electrical energy at the central stations.—Choice of the power of units.—Meters and tariffs.

2. *Transmission and Distribution.*—High tension lines; the regulation of high tension conductors along public roads; measures of safety for the public.—Connection to earth of the conductors in various systems of distribution.—Lightning and lightning conductors.—Automatic connection to earth of circuits in case of any accidental rise in the pressure.—Comparison of synchronous and asynchronous motors.—The employment of condensers.

3. *Electric Traction.*—Progress made in traction motors.—Comparison between the three systems: continuous current, triphase current transformed into continuous current by sub-stations, triphase current.—Traction on rails; automobile cars or trains; comparison.—Resistance of the air on cars.—Maximum pressure tolerated by public regulations for traction in city and suburbs, railways, and canals.—Construction of tracks.—Phenomena of electrolysis.

4. *Lighting.*—Luminous efficiency of the arc; comparison between the continuous current arc and the alternating current arc, the open and the enclosed arc. Coupling of arcs.—New incandescence lamps. Lighting of cars and trains.

Section III.—Electro Chemistry.

1. *Theoretical Researches.*—Conductivity of rarefied gases. Rate of transport of ions.—Chemical actions of the electric spark and brush. Organic compounds produced by electrolysis.

2. *Apparatus.*—Recent improvements in batteries. Standard cells.—Dry batteries.—Batteries with large output.—Accumulators in other metals besides lead.—Choice of a battery for traction, sub-station, or regulation. Industrial furnaces. Different arrangements adopted in large industries.

3. *Analyses.*—Separation and quantitative analysis of metals. Industrial methods of analysis in electrolytical works.

4. *Metallic Deposits.*—Deposits of chromium, aluminium, and zinc. Statistical documents giving, for each nation, the quantity of silver, copper, and nickel deposited annually.

5. *Metallurgy.*—Electrolytic treatment of ores of copper, zinc, lead, and nickel.—Treatment of mattes.—Polished metals obtained directly in electrolytic baths.—Industrial refining of copper.—Comparison between the prices of products obtained by electricity and of those obtained by other metallurgical processes.—Statistical documents relating to the quantities of electrolytic copper and nickel used in the various countries of production and consumption.

6. *Large Industries.*—Manufacture of chlorine and sodium by electrolysis; of chlorates of potassium and sodium; of carbide of calcium; of aluminium.

7. *Various Applications.*—Practical methods of producing and combining ozone.—Applications of ozone.—Preparation of hydrogen and oxygen.—Production of glucinium and its alloys.—Preparation of phosphate of calcium.—Treatment of sugared juices.—Dyeing and bleaching.

Section IV.—Telegraphy.—Telephony.—Various Applications.

1. *Generation of Electricity.*—Batteries.—Magnetic calls.—Employment of dynamos and accumulators.

2. *Lines.*—A. *Overhead Lines.*—Iron and steel wires.—Copper and bronze wires.—Bi-metallic wires.—Aluminium wires.—Insulators of porcelain and glass.—Wooden poles.—Methods of preservation.—Metal poles and supports.—Cross-arms.—Derricks.—Modes of construction.

B. *Underground Lines.*—Cables insulated with gutta-percha, india-rubber, paper, &c.—Armoured cables.—Lead-covered cables.—Modes of construction.

C. *Submarine Lines.*—Manufacture of the cores. Various qualities of gutta-percha extracted from leaves. Analyses of gutta-percha.—Cores with great speed of transmission.—Electric tests of cores.—Coverings of cables.—Armour.—The employment of steel of great strength.—Light cables for great depths.—Cables with strengthened shore-ends.—The utilisation of cables for telephony.—Cores with

air insulation.—Laying and repairing operations.—Ships.—Apparatus.—Sounding apparatus.—Grappling irons.—Buoys.

3. *Apparatus.*—A. *Telegraph Apparatus.*—Multiple apparatus. Step-by-step multiple apparatus.—Multiplex.—Phonic apparatus.—Rapid apparatus.—Apparatus for previous composition.—Apparatus for photographic registering.—Relays.—Relays for underground and submarine lines.—Accessories.

B.—*Telephone Apparatus.*—Transmitters.—Receivers.—Repeaters.—Various systems of exchanges.—Exchanges with indefinite capacity.—Exchanges with central battery.—Automatic exchanges.—Secondary central offices.—Subscribers' stations.—Systems of calls.—Relays.—Accessories.

4. *Systems.*—Overhead, underground, or mixed systems.—Single and double-wire systems.—Anti-induction lines.—Long-distance telephony.—Simultaneous telegraphy and telephony.

5. *Propagation of Currents in Telegraphy and Telephony.*—Lines of small capacity.—Lines of great capacity.—Rate of transmission.—Order of magnitude of the currents.

6. *Preservation of Telegraphic and Telephonic Communication.*—Disturbing influences due to the vicinity of industrial currents.—Induction of alternating currents and rectified currents.—Preservation of lines.—Insulators.—Wires.—Nets.—Automatic connection to earth.—Automatic cut-outs.—Preservation of stations.—Fusible circuit breakers.—Influence of storms.—Lightning conductors.—Earth Currents.

7. *Wireless Telegraphy.*—Various systems.—Oscillators.—Receivers.—Coherers.—Feelers.—Syntonisation of apparatus.—Communications with or between ships.—Optical telegraphy.

8. *Clockwork.*—Automatic winding.—Automatic setting to time.—Employment of telegraphic and telephonic wires for the unification of time.—Adaptation of electrical systems to the types of clockwork in present use.

9. *Various Applications.*—Various signals and calls.

SECTION V.—ELECTRO-PHYSIOLOGY.

1. *Production of Electricity by Living Beings.*—So-called currents of rest in different tissues; nerves, muscles, glands, &c. Currents of action or negative oscillation. Currents of the special organs in electric fish, methods and instruments for the study of these various currents.

2. *Action of Electricity on Living Beings.*—Influence of the form of the exciting electric wave; characteristics of excitation.—Electrifying by the static machine. Electrifying by induced currents.—Electrifying by sinusoidal currents.—Electrifying by undulatory currents.—Electrifying by high frequency currents.—*Processes:* direct, by condensation, by self-conduction, unipolar or bipolar, &c.—Instrumental appliances for the production and application of these various currents.

3. *Measuring Instruments and Various Physiological Effects.*

4. *Dangers of Different Modes of Producing Electrical Energy.* Death by electricity. Measures to be adopted with persons suffering from an electric shock.

During the Congress, visits in which members only can take part will be paid to the more important installations in Paris.

Applications for tickets for the Congress should be addressed to one of the secretaries of the Committee of Organisation, M. Paul Janet, 14, Rue de Stael, Paris, and the amount of the subscription (20 francs) sent to the treasurer, M. Leon Violet, 20, Rue Delaulre, Paris.

Members' tickets will include free admission to the Exhibition during the Congress.

THE EFFICIENCY OF THE GAS ENGINE.

BY ED. C. DE SEGUNDO, ASSOC.M.INST.C.E.

A GREAT deal has been written of late upon the subject of economical power production, and in dealing with the subject reference is frequently made to the superior efficiency of the gas engine as a heat machine.

To fix our ideas let us examine the results of a test carried out by Prof. Kennedy on a gas engine indicating about 18 H.P. Very careful analyses of the gas used showed it to have a calorific value of 20,800 thermal units per pound. The weight per cubic foot of the gas at the actual mean temperature and pressure of barometer during the trial was 0·0325 lbs., hence the calorific value per cubic foot was 20,800 × 0·0325, or 677 thermal units. The total amount of gas used in the trial was 1,409 cubic feet, and the total number of explosions was 35,712. Hence the gas used per explosion was 0·03946 cubic foot, or 0·001283 lb., which corresponds to a total available heat per explosion of 26·7 thermal units, or 20,620 foot-pounds.

So far we are able to obtain exact figures. For the purposes of calculating the absolute efficiency, it is only necessary to calculate the actual work done (net) by the charge of gas and air per working stroke from the indicator diagrams, which in this case amounted to 4,130 foot-pounds, and work out the ratio of heat turned into work—4,130 foot-pounds—to the heat supplied per working stroke, viz., 20,620 foot-pounds. This gives the absolute efficiency of the gas engine as

$$\frac{4,130 \times 100}{20,620} = 25{\cdot}6 \text{ per cent.}$$

This is nearly twice as high as that of a steam engine using, say, 22 lbs. of water per I.H.P. per hour.

Mr. Westinghouse, however, claims an even higher efficiency for his latest type of gas engine. He claims that his engine will give 1 I.H.P.-hour with a consumption of natural gas of under 8 cubic feet. The calorific value of natural gas may be taken at 1,000 thermal units per cubic foot at mean pressure and temperature, hence the performance of Mr. Westinghouse's engine is equivalent to an absolute efficiency of

$$\frac{2,545 \times 100}{8,000} = 31{\cdot}8 \text{ per cent.}$$

The best result in steam engine performance, of which the writer is aware, is that of a quadruple expansion steam pumping engine now at work at a pumping station of the Pennsylvania Water Company, near Pittsburg, the heat expended per I.H.P. per hour amounting to 11,158 British thermal units, and showing an absolute efficiency of

$$\frac{2,545 \times 100}{11,158} = 22{\cdot}8 \text{ per cent.}$$

Having regard to other considerations, a discussion of which would be too lengthy in this short note, it may safely be said that the limit of possible absolute efficiency is nearly reached in the latter figure as far as the steam engine is concerned.

The word efficiency may be interpreted in different ways; it is capable of nearly as many definitions as the word "load factor." But it will be admitted that in judging of the performance of any machine, as compared with that of another machine, it is only fair that its maximum capacity should be taken into consideration as well as the actual work it does. This is tacitly assumed when the *mechanical* efficiency of one engine is compared with that of another, but in comparing the amount of heat turned into work in a steam engine with that utilised by the gas engine, it is sought to compare two things which are not strictly speaking comparable in that the same standard does not apply to each.

Between 1819 and 1824 Carnot wrote his now famous little work, "Reflexions sur la Puissance Motive du Feu," in which the following passage occurs: "We should not expect ever to utilise in practice all the motive power of combustibles;" and again, "The motive power of heat is independent of the agent employed to realise it; its quantity is fixed solely by the temperatures of the bodies between which the heat transfer finally is effected."

Arguing upon this basis, the following expression is arrived at for the maximum amount of heat supplied to an engine which it is possible for the engine to turn into work.

$$E_c = \frac{T_1 - T_0}{T_1},$$

where E_c* is the Carnot efficiency (the suffix c to distinguish it from a similar expression evolved by Rankine).

T_1, absolute temperature at which steam is received by the engine.

T_0, absolute temperature at which steam is rejected by the engine.

Working out the efficiencies of the gas and steam engines before referred to upon these lines, we come to a very different result.

In the gas engine the initial and final temperatures were 2,155° F. and 110° F. respectively, corresponding to absolute temperatures of 2,615° and 570°. Hence the greatest amount of heat supplied which the engine could possibly turn into work would be represented by the fraction,

$$\frac{2,615 - 570}{2,615} = 78{\cdot}2 \text{ per cent.;}$$

the gas engine turned 25·6 per cent. into work, hence its *relative* efficiency is

* A more complete statement of the case is effected in the expression based upon the Rankine cycle, but for the purposes of this paper the simpler form is quite sufficient.

$$\frac{25{\cdot}6 \times 100}{78{\cdot}2} = 32\,7 \text{ per cent.}$$

The initial and final temperatures in the cycle of the steam pumping engine were 311° and 105°.

The Carnot efficiency is, therefore,

$$\frac{772 - 566}{772} = 26{\cdot}5 \text{ per cent.,}$$

but the engine turned 22·8 per cent. of the heat supplied into work, hence its relative efficiency is

$$\frac{22{\cdot}8 \times 100}{26{\cdot}5} = 80 \text{ per cent.}$$

The figures for Mr. Westinghouse's gas engine do not appear as yet to have been published, but its relative efficiency may be approximately calculated from that of the gas engine above, worked out thus:

Westinghouse engine yields 1 I.H.P.-hour with an expenditure of 8,000 thermal units.

The gas engine above referred to, requires an expenditure of 12,800 thermal units per indicated horse-power-hour, hence the efficiencies will be roughly in the proportion of $\frac{12,800}{8,000}$

or relative efficiency Westinghouse engine $= 32{\cdot}7 \times \frac{12,000}{8,000}$

$= 52{\cdot}3$ per cent.

Although there is no doubt that more room for improvement exists in the case of the gas engine heat efficiency than in the steam engine, still it may fairly be assumed that on practical grounds the limit of efficiency must now have been nearly reached in the gas engine. It is probable that the steam engine will always be a more efficient machine than the gas engine for turning heat into work, *having regard to the respective limitations of the two machines.*

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS.—1900.

Compiled expressly for this journal by W. P. Thompson & Co. Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, Manchester and Birmingham, to whom all inquiries should be addressed.

9,750. "Improvements in junction boxes, crosses, tees, bends, draw-in boxes, and other fittings for metallic conduits for electric cables and wires, and for similar purposes." Cope, Allman & Co., Limited, and W. Allman. Dated May 28th.

9,751. "An automatic disc-catch lever switch for electric tramways." S. Eyre. Dated May 28th.

9,753. "Improvements in the contact arm and contacts of motors starting and similar switches." A. H. Mayes. Dated May 28th.

9,760. "Improvements in electrical maximum-demand indicators." G. Hookham. Dated May 28th.

9,767. "Improvements in the method of splicing cables." T. J. McTighe. Dated May 28th. (Complete.)

9,768. "Improvements in the manufacture of electric railway rail bonds." T. J. McTighe. Dated May 28th. (Complete.)

9,781. "Improvements relating to primary batteries." E. P. L. Mors. Dated May 28th.

9,784. "Improvements in electric switches." W. F. Jones. Dated May 28th.

9,822. "A new or improved method and apparatus for automatically operating and controlling signal lights on board ships where electricity is employed." J. W. Garrett. Dated May 29th.

9,873. "Improvements in electric motors, batteries, and connections thereof, for propelling automobiles and like vehicles." J. Hewitt, C. A. Lindstrom, and T. Hewitt. Dated May 29th. (Complete.)

9,879. "Improvements in 'Nernst' lamps having automatic heat current interrupters." R. Krayn. Dated May 29th. (Complete.)

9,944. "Improvements in incandescent electric lamps." B. M. Drake and The Nernst Electric Light, Limited. Dated May 30th.

9,953. "Electric switches." A. T. Baldwin. Dated May 30th.

9,954. "Electric air pumps." A. T. Baldwin. Dated May 30th.

9,955. "Improvements in electric railway systems." The British Thomson-Houston Company, Limited. (W. B. Potter, United States.) Dated May 30th. (Complete.)

9,957. "Improvements in telephone signalling systems." N. H. Holland. Dated May 30th.

9,962. "Improvements in or relating to alternate current induction motors." G. W. Money. Dated May 30th.

9,968. "Magnetic separators." O. Imray. (Mechernicher Bergwerks-Actien-Verein, Germany.) Dated May 30th. (Complete.)

9,971. "An improved method of utilising electrical earth currents." E. Jahr. Dated May 30th.

9,988. "Electric signalling device for preventing railway collisions." G. D. Monaco. Dated May 30th.

10,001. "An improved method and means for controlling the speed of electric motors." C. W. Dawson. Dated May 31st.

10,022. "Improvements in electric tramways or railways on a conduit system." M. Gaughren. Dated May 31st.

10,026. "Electrical appliance for working pile drivers." J. Garvie. Dated May 31st.

10,029. "Improvements relating to the distribution of electric current." N. W. Storer. (Date applied for under Patents, &c., Act 1883, Sec. 103, November 1st, 1899, being date of application in United States.) Dated May 31st.

10,065. "Improvements in automatic magnetic circuit breakers." W. R. Lake. (W. M. Scott, United States.) Dated May 31st.

10,074. "Improvements in electric brakes." F. C. Newell. Dated May 31st.

10,075. "Improvements in, or in connection with, trolley or like current collectors for electric railways and tramways." J. W. Martin. Dated May 31st.

10,081. "Electric fuse." I. Kitsee. Dated May 31st.

10,105. "Improvements in adjustable resistances." A. H. Mayes. Dated June 1st.

10,121. "Improvements in electrically propelled velocipedes, carriages, and other like vehicles." C. Adams-Randall. Dated June 1st.

10,124. "Calling appliances for telephone switchboards." J. E. Kingsbury. (The Western Electric Company, United States.) Dated June 1st.

10,133. "Improvements in and relating to electric meters." T. Duncan. Dated June 1st. (Complete.)

10,134. "Improvements in electric meters." T. Duncan. Dated June 1st. (Complete.)

10,137. "Improvements in or connected with electric lamps." R. Krayn. Dated June 1st. (Complete.)

10,172. "Improvements in apparatus for starting and controlling electric motors." T. Preece. Dated June 2nd.

10,181. "Electrical steam boiler." C. E. Griffing. Dated June 2nd. (Complete.)

10,197. "Improvements in electrodes." K. A. Wilde. Dated June 2nd.

10,210. "Improved electrical apparatus for closing steam supply valves from a distance, and giving an audible signal." E. G. Dahl. Dated June 2nd. (Complete.)

10,214. "Improvements relating to electrical ignition devices applicable to internal combustion and like engines, and to other purposes." J. A. McMullen. Dated June 2nd.

10,219. "Improvements in electricity meters." W. L. Wise. (Lux'sche Industriewerke Actiengesellschaft, Germany.) Dated June 2nd. (Complete.)

10,231. "Electrical alarm for automatic fire-extinguishing sprinkler installations." E. Chadwick. (H. Tetlow, Russia.) Dated June 2nd.

10,230. "An improved arrangement of underground mercury contact for electric railways and tramways." L. Bachelin. Dated June 2nd.

10,231. "Combined rheostat and attachment plug." L. D. Carter. Dated June 2nd.

ELECTRICAL PATENTS OF 1886 EXPIRING IN JUNE, 1900.

We are informed by W. P. Thompson & Co. that about 90 applications for electrical patents were filed in June, 1886; of these some were never completed, and of those that were only two have been maintained to run their full term, viz., 14 years, and being of considerable interest we give short abstracts of them below:—

7,311. "Improvements in multiple electric conductors or cables for telegraphic, telephonic and other purposes, and in processes and apparatus for the manufacture of insulated conductors and cables." B. J. B. Mills. (J. J. C. Smith and M. Smith.) Dated June 1st, 1886. Hollow electric cables are constructed with a core either of copper wire wound in a close spiral or perforated lead tubing, covered with a layer of cotton thread. Over the core layers of insulated copper wire are wound in long spirals, each layer being reversed to the adjacent one; these are covered with an overlapping spiral of cotton tape covered on the outside with rubber composition. The cable is next coated with a layer of rubber composition, having a coat of metal foil on its outside. Next come reversed spirals of cotton tape covered on each side with rubber composition. At this stage the cable is vulcanised by steam at a temperature of 250° F. for 40 minutes. For this operation the cable is wound on a large drum which is slowly rotated to prevent the wire from moving from the centre of insulation. The cable is armoured by two layers of wire, one of fine wire in long spirals, and the second of short spirals of thicker wire. The cable is finally attached to pumping apparatus, and all the air and moisture removed by passing heated oil through it and filling with melted paraffin wax. 15 claims.

6,531. "Improvements in and connected with the manufacture of aluminium and other light metals." F. I. R. Seaver. (Dr. E. C. Kleiner-Flertz.) Dated June 29th, 1886. Relates to electrolytic furnaces for obtaining aluminium, &c. The metal is obtained from its fusible compounds by the action of an electric current without the aid of external heat. In one form of the apparatus the vessel is lined, preferably with baucite; the negative electrodes project through the bottom, while the positive are arranged to hold a number of carbon rods, and are counterweighted so that they may be easily adjusted. The material is packed around the carbon rods, and the reduced metal sinks to the bottom or rises to the top according to its destiny.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson and Co., 322, High Holborn, W.C., and at Liverpool, Manchester, and Birmingham, price, post free, 9d. (in stamps).

1899.

12,011. "Improvements in electric gas igniters." F. Deimel, J. Lehmann and A. Lyttes. Dated May 26th, 1899. The electric torch consists of a hollow handle containing the battery or accumulators, and a cover and extension containing the connections, the leads, and the switch. At the upper end of the torch, which is shaped in the known manner for operating gas cocks, the leads pass laterally to a cap within which the incandescing platinum wire is arranged. When the cap is placed over the gas burner and the circuit completed by means of the switch, the wire becomes incandescent and ignites the gas. Should the tension of the electric current be less than 1·8 volts, the ignition is ensured by fitting a platinum black igniter in the platinum loop. The electric current warms the igniter, which is then rendered incandescent by the escaping gas. 3 claims.

12,016. "Improvements in systems of electrical control for elevators." H. N. Leigh. (F. J. Sprague.) Dated May 26th, 1899. An electromotor has its armature mounted upon a shaft upon which also a worm is fixed. This worm gears with a spur wheel on the shaft of the winding drum. The hoisting rope passes up the well over a pulley to the cage. The balancing rope passes under the pulley up the well, and then over another pulley to the balance weight of the cage, plus part of the load. Under some circumstances, therefore, the motor acts as a generator. The electrical control system described diagrammatically in the specification is arranged so that the closure at a button at any landing will cause the lift cage to travel toward and stop automatically at that landing. Buttons which correspond to the several landings are placed within the cage, so that the closure of any one causes the cage to travel automatically to the corresponding landing and stop there. When the controlling circuit is thus closed in the cage or at a landing, the unoperated buttons at the other landings are automatically and magnetically locked to prevent the establishment of a conflicting circuit. The direct control of the motor is effected in a similar way

to that described in Specification No. 4,549, A.D. 1898; the pilot motor, however, used in that case to regulate the resistance in the armature circuit, is replaced in the present case by a solenoid. 9 claims.

12,190. "An improved chemical composition for the manufacture of mantles or blocks for use in electric arc lamps." P. Mersch. Dated May 28th, 1898. Incandescent arc lamps. Refractory tubes or blocks to be placed around or between the carbons are made by intimately mixing 4 parts of dry plastic clay, 3 parts of alumina, and ¼ part of kaolin. Water is gradually added to form a paste, which is moulded and submitted to prolonged baking. 1 claim.

12,201. "Improvements in apparatus for obtaining synchronous movement at the ends of submarine cable or other telegraph lines." S. G. Brown. Dated May 31st, 1898. Relates to apparatus for obtaining synchronous movements at the ends of submarine cables or other telegraph lines. The rotating contact-maker has a toothed iron periphery formed in segments and is driven by electro-magnets which receive periodic currents from a battery. The contact breaker is governed by the tuning fork kept in vibration by the electro-magnet. The pendulum at the centre of its swing makes momentary contact with a mercury globule, and allows the passage of a current from the battery through one pair of brushes. This should happen exactly at the time when the other pair of brushes bridge the gaps between the opposite segments; if they do not, the current passes through the polarised relay and actuates mechanism to raise or lower weights on the arms of the tuning fork, thus altering its rate of vibration. 6 claims.

12,220. "Improvements in or connected with electrically driven vehicles." C. Jeanland and W. C. Rechniewski. Dated May 31st, 1898. Relates to means for starting, stopping, and reversing electrically driven vehicles in which an appliance is provided for controlling the supply of current to the motor for starting, regulating the speed of, and reversing the vehicle. A device is provided for throwing resistance into the circuit, for short-circuiting the motor, and for applying a brake to the motor or some intermediate shaft; while an appliance is described for breaking the circuit suddenly, and for applying a safety brake to the wheels or axles of the vehicle. All three are mounted on a vertical shaft, the cylinder of the first device being keyed on it, while the moving portions of the other devices are loose and operated by pedals. The cylinder is composed of insulating material and carries contact pieces. These make contact with the brushes. By rotating the cylinder by means of a lever, the motor is driven in the required direction, and at the desired speed, or it may be stopped altogether. The cylinder is also of insulating material, and carries contact pieces. It is rotated by a pedal, which pedal through a chain also applies a brake to the motor or an intermediate shaft. The cylinder is returned after any movement by a spring under the control of a dash-pot. The safety device consists of a disc of insulating material carrying a piece which normally completes the circuit through two points. This disc is held by a pawl which can be released by a pedal. When this takes place the spring rotates the disc to break the circuit through the above points, and apply a brake to the wheels or axles through a chain. 4 claims.

12,860. "Improvements in telegraphy by means of electric light." K. Kickler. Dated June 8th, 1898. Relates to telegraphing by means of ultra-violet radiations from a source of light without the use of a metallic connection. The transmitter consists of a holophote arrangement of an electric arc lamp provided with a rocksalt or quartz focussing lens and a glass or other suitable shutter operated by a pneumatic arrangement similar to a photographic shutter. The receiver consists of a partially exhausted tube provided with a spark gap between the terminals upon which the beam of light is focussed by means of a quartz, &c., lens. The terminals are connected to an induction coil so adjusted by the resistance that the spark cannot pass until the ultra-violet rays fall on the spark gap. The signals may be received by the sparks, a telephone, or other apparatus arranged in circuit with a coherer which is excited by the Hertzian radiations due to the spark discharges. 3 claims.

12,880. "Improvements in the method of and means employed for connecting the guard wires of electric cables, and for disconnecting same in case of breakage." R. Bostock and F. A. Cheetham. Dated June 9th, 1898. Relates to means for supporting the guide wires of electric railway conductors, &c., so that they may become detached in case of breakage. Hooks engage slotted plates to which the wire may be attached by a tightening screw. Weighted levers connected to the hooks by links withdraw them when the wire breaks and allows it to fall. 3 claims.

13,037. "Improvements in electric glow lamps." The Spiral Globe, Limited, and B. C. E. Parker. Dated June 10th, 1898. Incandescent lamps. Bulbs are provided with internal light-refracting coils of glass rod. This is effected by winding the glass rod on a former, and placing the coil within a cylinder, which is then contracted on the coil to form a bulb. The contraction may be performed by closing the cylinder and exhausting air from it through a tube. By another method a bulb is blown of the desired size, cut in two, placed over the coil, and reunited by welding a thin strip of glass on its edges. 2 claims.

13,137. "A new or improved apparatus or holder for carrying carbons or electrodes for use in electric welding, brazing and the like purposes." G. W. de Tunzelmann. Dated June 11th, 1898. The electrodes of an electric arc are used for brazing, welding, or local heating generally are mounted in clips carried by pieces sliding on guides secured to parts of the frame. One clip is pivoted on the piece and one guide is pivoted to the frame, the pivots allowing the angle between the electrodes to be varied. The pieces are adjusted by screws, one of which can be moved laterally against a spring to strike the arc. The parts of the frame are secured to an insulating block with a handle. This handle and a second handle have shields. The apparatus may be slung by a link. When the angle between the electrodes is very acute, a wedge of refractory material may be placed between them, or they may be coated with a refractory material which only melts in the arc, to prevent the arc from creeping up the sides. 2 claims.

13,300. "Improvements in or connected with screens, shades or covers for electric lights." C. C. Bruff. Dated June 14th, 1898. Globes and holders therefor for electric incandescent or arc lamps. A globe is held within or on a cover by catches, the cover being carried by an ordinary lampholder. The globe and cover may be made of ground or opal glass, but are preferably of translucent china, formed in a plaster or other mould, and fired and glazed. The catches may be steel clips attached to the cover by split rivets and washers and adapted to grip a rim on the globe. The clips may be on the globe and grip a rim on the cover, and their inner arms may be dispensed with. They may be secured by heads on them, and passing them through washers and holes in the globe, forming separate rivets being dispensed with; a wire ring may then be passed through the heads of all the springs on the globe to keep them in position. In another arrangement springs which grip or enter holes in the rim of the globe are arms of a flat ring, which is secured on the lampholder above the cover. A wire may be bent to form the ring and two arms, which are provided with knobs at their ends. The cover may be dispensed with, or replaced by a reflector. In another arrangement springs are dispensed with, the rims of the globe and cover being made with projections and recesses to engage together as a bayonet joint. 5 claims.

13,304. "Improvements in electric arc lamps." A. M. Arter. Dated June 14th, 1898. Arc lamps. Solenoid regulating mechanism is arranged so that the carbon holders are connected by rods, a chain and cords to opposite sides of a pulley, which may have two grooves of different sizes to allow unequal movement of the carbons. The cord from the heavier upper holder passes over a stationary guide wheel. The pull is supported by a frame and a spring. The pivot may be below the pulley or may be coaxial with the pulley. A cord is attached to and wound on a part of the pulley, of small diameter, and carries a lever on which is the core of a series or differentially wound solenoid. Or the cord may itself carry the core. A dash-pot controls the movements of the core or frame. In operation the pull of the heavier upper holder on one side of the pulley is balanced by the pull of the cord due to the solenoid on the other. The chain prevents the cord from being lifted from the pulley if the lower holder is lifted. In a modification the lamp is inverted, the regulating mechanism being connected by cords with rods which extend upwards and carry the carbon holders. In another modification, described also in Specification No. 27,696, A.D. 1898, the pulley is of larger size, and slotted to pass the pivot, both cords depending directly from it; it is weighted to compensate for the varying difference in weight of the carbons when continuous current is used. A toothed wheel and racks may be used instead of the pulley and cords. For alternating current the solenoid core consists of a series of flat discs. 4 claims.

13,312. "Improvements in electric incandescent lamps." O. H. Michaelson. Dated June 14th, 1898. Incandescent lamps. A bulb has its open end channelled to clamp a rubber or other packing-ring against a glass or porcelain base by atmospheric pressure after the parts have been put together in an exhausting apparatus. The parts may be readily separated for cleaning or renewing the filament. The base is fixed in a metal cup which also contains an insulating ring, provided with a nut and a contact ring attached to the leading-in wires. The ends of the wires are split to receive the ends of the filament, and are closed thereon by sliding sleeves. 1 claim.

13,316. "Improvements in or relating to telephone installations." J. T. Lara. Dated June 14th, 1898. Relates to the use of a common generator at the exchange for calling. Each subscriber has a branch from an extra common wire and earth return or from an extra common metallic loop circuit. A special calling switch is provided in which the subscriber's ordinary circuit is connected to two bridges, the wires leading to the apparatus being connected to under springs, and the special calling circuit being connected to upper springs. The upper springs are provided with contacts and with insulating projections for depressing the springs. 2 claims.

14,132. "Improvements in and relating to electrical furnaces, more particularly applicable for the production of calcium carbide." W. L. Durban and J. Gore. Dated June 25th, 1898. An incandescence furnace for making calcium carbide, or for other purposes, consists of refractory slabs fitted in grooves in metal end frames, which are held together by insulated tie-rods. The sides are further supported by bolts passing through them into eyes carried on the tie-rods with intervening asbestos insulation. The electrodes between which the incandescent conductor is held, are supported by ball joints packed with asbestos, on oppositely threaded shafts, so that they may be turned in the furnace, or tilted upward by rollers on arms of hand levers. The shafts are supported so as to be movable longitudinally towards or from each other by nuts on toothed wheels which are rotatable by pinions on a side shaft. The pinions are movable along the side shaft, or this is movable laterally in its bearings to disengage the wheels so that the electrodes may be independently adjusted. 3 claims.

14,293. "Improvements in systems of electrical distribution." R. Belfield. (C. F. Scott and B. G. Lamme.) Dated June 28th, 1898. Relates to means by which direct-current motors can be operated at variable speeds from an alternating current circuit. A rotary transformer or converter is employed to convert the alternating current into a direct current, a step-up or step-down transformer provided with means for altering the relative length of the primary and secondary being employed to vary the electromotive force. The invention is described as applied to an electrically operated vehicle. The alternating current is supplied from an overhead conductor through a trolley to a transformer. The secondary of the transformer is divided into sections, and is connected to the converter through a switch. The motors are supplied with a direct current. In order to secure a constant speed of the converter, a synchronous motor may be supplied with current from one of the sections of the transformer. A separate exciter or a battery may be employed for starting. 3 claims.

14,294. "Improvement in regulation of rotary transformer direct current electromotive force." B. G. Lamme. Dated June 28th, 1898. (Date claimed under Patents, &c., Act, 1883, Sec. 103, February 10th, 1898, being date of application in United States.) Relates to means for regulating the electromotive force of direct currents for rotary transformers or converters supplied with alternating current. The generator supplies two-phase currents to a stationary transformer the secondary of which is divided into sections which may be connected as desired, through switches with the rotary converter. A rheostat is included in the field. The regulation of the electromotive force impressed on the direct-current circuit is obtained by varying the number of sections of the stationary transformer in the circuit and by varying the resistance in the field. Choking coils are included in the transformer circuit, or a separate coil may be included in each of the leads. 3 claims.

14,316. "Improvements in and relating to dry and other galvanic batteries." A. E. J. Ball. Dated June 29th, 1898. Relates, firstly, to a dry cell consisting of a zinc cylinder, a carbon cylinder or rod packed around with a depolarising mixture, which is held in place by a porous cylinder and an electrolyte which is solidified by the addition of plaster of Paris and flour to it. The electrolyte consists of an aqueous solution of the chlorides of aluminium, ammonium, and magnesium, but either the aluminium chloride, or the magnesium chloride, may be dispensed with. The cell is closed by a bitumen sealing and a chamber and exit tube provided for the collection and escape of the gases evolved. The wire from the zinc is surrounded near the zinc with a strengthening metallic spiral. The invention also relates to a fluid battery of similar construction, in which the above-described liquid or ammonium chloride is the electrolyte, and the carbon electrode stands on an insulated foot or base. 6 claims.

14,318. "Improvements in dynamo-electric machines and motors." S. G. Brown. Dated June 29th, 1898. For the purpose of economising material and obtaining easy commutation, one or more of the field poles are made sufficiently strong to effect the commutation of the whole of an armature section, while the others are wound with fewer ampere-turns and given a smaller air-gap or clearance. In a multipolar machine with series-wound drum armature, for example, one field pole is wound with a larger number of ampere-turns than the others, and the air space of the latter is reduced. The span of the pole may be increased by extending it in one or both directions round the armature, while its active area may be diminished by slotting it. Instead of a single pole, alternate poles may be made stronger than the others. In a bipolar machine having a divided magnetic circuit, the span of one polar face may be increased and its area diminished as described above. 10 claims.

14,361. "Improvements in and relating to the coupling of alternating current dynamos or alternators and the like." J. A. McMullen. Dated June 29th, 1898. Relates to the coupling of dynamos. Alternators have their armatures mounted on hollow shafts and are placed so that these shafts are accurately in one line. Each shaft carries a driving pulley. A smaller shaft passed through all the hollow shafts, is supported in them, or by bearings between them, and carries clutches to connect with any of them. Alternators at the ends of a line may have solid shafts. 3 claims.

14,896. "Improvements in or applicable to vacuum brake apparatus for vehicles or trains propelled by steam, electricity, or other motive power." J. Gresham and H. E. Gresham. Dated July 6th, 1898. Relates to vacuum brakes for vehicles or trains propelled by steam, electricity, &c. Two train pipes communicate through flexible pipes with the lower and upper sides of a brake-operating piston working in a cylinder carried on trunnions. The pipe always communicates through a passage with a port leading to a vacuum reservoir, from which air may be withdrawn by an exhauster driven by the vehicles or by a separate electric or other motor and connected to a port, When a port in a hollow conical plug registers with the pipe air enters through holes in the bottom of the plug, and passes to the underside of the piston and applies the brakes. When the plug occupies a half-turned position, the pipe communicates through a port with the vacuum chamber, and the pressure on each side of the piston being equalised the brakes are released. 5 claims.

22,070. "Improvements in and relating to galvanic batteries." C. Lovetus. Dated October 20th, 1898. Relates to electrolytes for two-fluid cells, one electrolyte consists of nitric acid 12 per cent., nitrous acid 8 per cent., hydrochloric acid 50 per cent., water 30 per cent. by weight, or nitrous acid may be used instead of the nitric acid. This solution is put with the carbon electrode. The solution may be strengthened when partially exhausted by a more concentrated solution of the same acids or by the addition of chlorine and oxygen in any convenient way, also nitric oxide or other oxide of nitrogen. Another depolarising agent nitrosyl sulphuric acid is dissolved in water. In another modification nitrogen pentoxide is passed into nitric acid. Any gas coming from the cells is passed into condensers containing a solvent. When this becomes sufficiently impregnated with gas it can be used in the battery. 6 claims.